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Automatic Bottle Manufacture

By GEORGE E. HOWARD*

Historical

The making of bottles and hollow ware by hand with the blowpipe and a mold to form the outer configuration of the ware has been a skilled art dating back into antiquity. With mechanical replacing the manual operations in industry, it was natural that efforts to reproduce the work of the skilled artisan in glass should be attempted.

The subtle characteristics of molten glass at the working state, more especially its viscosity or, as the glass worker terms it, "its nature," required an unusual degree of manual skill and constant mental alertness. The range, flexibility, delicacy and great variety of motions required to effect the manual operation, made mechanical substitution almost impossible.

At a date within the memory of men still active in the industry, a very radical step was taken in the introduction of the blank system. This system divided the process of making a bottle into two parts and thereby divided the difficulties to be overcome in introducing mechanical apparatus, so that the problem of pressing and blowing was separated from the problem of gathering the hot glass from the furnace.

The problem of mechanically pressing and blowing was accomplished first, and as this article has to do more especially with feeding or gathering the glass, the other half of the process, we will not take it up in detail.

While the introduction of the blank system was the means that made solution possible, the real achievement in bottle making was the invention and development of the Owens bottle machine which solved both the gathering and the blowing problems, and combined these functions into one automatic process.

It was the greatest forward step in the industry in four hundred years.

Prior to this invention, however, the idea of separating a mass of molten glass from the parent body in the tank furnace was attempted and efforts were made to feed semi-automatic pressing and blowing machines with automatic feeders. The earliest attempts consisted of flowing the stream from an opening and cutting it with shears, delaying the downward movement of the oncoming stream with cups, or resting it temporarily on the shears while the molds were changed to another position.

This line of development eventuated in the feeder known as the Brooke type, which was little more than a cutting and husbanding device, and the long contact of part of the gather with the cold cup and shears made great unevenness in the temperature and viscosity of the gather as it dropped into the mold, particularly as part of this gather did not touch the cup but fell directly from the flow opening into the mold.

When the ware was blown, sufficient time had not elapsed to even up the temperature in the mass and the ware had very uneven distribution of material. Another difficulty was the trapping of air bubbles by the lapping of the hot glass as it fell into the mold. This is the oldest of automatic processes and with it commercial ware is still made, such as small, wide mouth bottles, inks, vaselines, tumblers and green fruit jars.

Following this development, inventors endeavored to substitute for the manual movements, mechanical ones, as the gathering operation had been simplified to merely wrapping a wad or gob of glass on a punty, allowing it to shed or drop from the punty, then severing same by shears.

These mechanical movements, while simple as compared to the work of blowing a bottle by the hand or blowpipe method, were still so complicated that the sensitiveness of the operation doomed these attempts to failure.

Many patents were taken out in all countries, covering this method, and from time to time there is a revival of this scheme.

The next general phase of activity was to delay the passage of the glass from the flow opening during the transfer of molds, interrupting the flow and holding glass in container for a part of cycle. In this work, Brookfield was the pioneer and he used for his scheme a valve or plunger which alternately increased and lessened the flow from the opening, cut

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off the stream near the opening and shortened the time in which the glass flowed and formed the gob or gather. Brookfield did not drop the glass directly into the mold but caught the gather upon a revolving cup and while it did not entirely overcome the faults of the other system, yet it formed the next important step in reducing the differences of temperature in the gathered glass.

This system has been improved, the delaying or supporting cup eliminated, and it forms the basis for the present day successful automatic feeder.

Coincident with Brookfield were a number of attempts to form a mass of glass without contact with shears or cups, termed for convenience, "the pouring method." These methods reached commercial application, especially in the plate glass industry where large lumps or gathers of glass were delivered from furnaces and came in contact with no chilling influence until placed upon the table where they were rolled into sheets. This was done mechanically and the surviving methods pertain to delivery from large pots or receptacles.

Attempts were made to introduce this method with tank furnaces and a long list of inventions covers this phase of the activity, but none has been used commercially except the Hartford-Fairmont paddle feeder, which reached a commercial stage before its abandonment in favor of the plunger or Brookfield type.

There were a number of other attempts, notably one in which moving parts were eliminated from the apparatus and vacuum and pressure applied on the surface of the glass in the boot or forehearth, in an attempt to interrupt the flow and form masses of molten glass without contact with intervening apparatus between flow hole and mold. These attempts did not reach a commercial stage, and in fact were not even operable.

ANALYSIS OF THE ART

Within the last ten years the manufacture of glass has been almost entirely an art, science having little or no part to play as an aid to securing better results, but within this period many additions to the science of glass making by the chemist and the physicist have given the engineer and inventor valuable material with which to work out apparatus and methods for successful feeders.

The manufacture of bottles under the blowpipe or hand method was largely a matter of art or skill, and apparatus needed was of the crudest character.

Little or no attention was paid to plant management, refinements of detail or other conditions.

The Owens machine with its intricate machinery and sensitive conditions under which it had to operate, compelled attention to these matters, and as it depended upon electricity and air and other working forces, made at a central station and distributed to the various units, it brought in the question of co-ordination of the factory and the organization of an efficient personnel.

FEEDERS DEVELOP IMPORTANT DETAILS

The feeders of the earlier times, even the crude ones, compelled close attention to time and temperature and also assisted in making familiar these then new factors of plant management. Differences in the character of the glass made affected the results and brought attention to the necessity for more careful batch mixing and uniformity of the raw materials.

The mechanical blowing machine also brought out the necessity for accurate work by the mechanic and constructor and the expansion of the blank which was chilled by contact with iron, brought out the great difference between expanding these blanks into full sized ware and the expansion of the gather on the blowpipe with the hand operator. During the last five years the feeder using a suspended drop and shaped closely to the configuration of the blank mold has made rapid strides and it is the prevailing type of feeder for high grade work.

CYCLES IN DEVELOPMENT

As in all phases of mechanical development there run certain cycles, so with the feeder has occurred a return to more primitive types, improved with the new knowledge gained in the art. The study of stream lines and the action of surface tension on the glass in passing an opening has enabled inventors to return to the cup or husbanding type of feeder and improve it considerably over the first attempts made in this line.

A notable example of this is the Proeger feeder, later improved and known as the Graham type, which cuts the glass and husbands it closer to the opening, avoiding the extreme lapping of the stream in the Brooke device and enabling a higher grade of bottle to be made than was made with the original Brooke.

However, at the present writing, the feeders having gathers suspended at the opening until severance by the shears are the prevailing type for high grade ware.

It is the opinion of the writer that invention will again return to the type known as the Brooke, and eliminate more of the difficulties originally encountered and still encountered by the Graham type, and it would be very hard to say what will be the final type of feeder to command the leadership of the art.

This is especially true when we consider that in all feeders the glass eventually drops into a blank mold and has a chilling action preliminary to its further expansion into bottles, and the only difficulty in the Brooke or husbanding type has been that this chilling occurs in the wrong places or in too great a degree in some places.

The feeders with the suspended gather, such as the Hartford-Fairmont, the Brookfield, and the feeder named for the writer, have certain difficulties and points of sensitiveness that do not occur in the Brooke, and a combination of these types may be the next step.

FEEDER LIMITATIONS

There are some objections to the feeder in any form, one of which is that the accuracy of weight and shape depends upon very close attention to time and viscosity and the chemical characteristics of the glass, whereas with the type such as the Owens, these points of sensitiveness are less evident, and the Owens type is more independent of time and viscosity and has a much wider range of temperature than the

feeder, although in all there is a best point which it is the object of good management to determine and maintain.

In feeders generally, the weight of ware has to be somewhat greater in order to produce satisfactory bottles, especially in the light type of bottle such as prescriptions. Also both the feeder and the hand fed semi-automatic machine have a minimum weight which is not as low as the old hand blown process.

Further developments in the feeder and the machine will, and in fact already have, greatly extended these limits, but it still remains one of the difficulties to be overcome.

In the Owens machine there seems to be no limit to small or light ware and with the multiple mold it is the judgment of the writer that for bottles under three ounces and for large orders there is nothing in the feeder principle that will warrant its replacing this process. However, in ware above three ounces and with smaller orders and diversified business there will be relatively more feeder production in the future.

FEEDER VS. OWENS PROCESS

Fundamentally, feeders have the advantage over the Owens machine. It is an example of the old story of evolution. The Owens machine moves several tons to the glass and back and even in its most improved form it moves very heavy mechanism into and out of the glass. As against this, the feeder moves the glass weighing a few ounces to the machine.

It is needless to point out that the cost of the mechanism, power, maintenance, lubrication, etc., of moving parts increases with the complication and size of the machinery. Conforming to this also is the heat differential. The Owens machine cools the glass by reason of contact of the mold with the glass and it therefore requires a large body of glass constantly moving to equalize the temperature for the next gather. This is done with the well known revolving tank.

In the best feeders the contact with the gather is limited to the shearing edge of the severing mechanism, and this operation has been so highly developed that practically no chilling takes place and the small amount that exists is equalized by the hot glass in the gather absorbing the slight chilling caused by the shears, thus eliminating the expensive revolving tank.

Despite these two fundamental handicaps in the gathering portion of Owens process, its superior blowing mechanism overcame these handicaps. The rapid advance in blowing machines has so nearly evened up matters that these newer machines combined with feeders are passing the Owens system in efficiency and low cost.

APPLICATION

The pertinent question today for the manufacturer is whether to adopt feeders and what type of feeder. In order to intelligently bring out the answer, one must consider the bottle or container itself in its fundamental aspects, and the question in the United States involves also certain aspects of American psychology.

First—America has definitely set itself in the direction of individual development, or the highly competitive system, as against Sovietism or Socialism or those forms of governmental psychology that encourage the leveling of people rather than the encouragement of individual excellence.

Second—The bottle or container is not a primary article but its sole purpose is to hold and package the primary article which is the content.

Third—Generally speaking, bottles are articles of everyday household use and this means that in general everybody uses every kind of bottle.

Feeders, without reference to type, may be divided into two classes: Those which aim for large quantity production and low cost, and those which aim for flexibility and smaller production per unit.

Almost any feeder is practically unlimited in speed and the speed limit is determined by the ability of the machine to carry away the glass fed.

As machines increase their number of molds, the mold expense for any one order increases; also there is a very definite limit to speed in the general line of semi-automatic machines owing to the fact that they stop and start as each bottle is made and the inertia of the moving parts reaches a point very much under the speed of the feeder.

Next to consider is the question of quality. When a gather is formed and cut off properly the glass is in its best condition for working, and the more directly and quicker that it reaches the mold untouched or undisturbed the better the article to be made. This favors the individual feeder set in unison with a single forming machine and thus limits the speed of the feeding unit to that of the machine.

In order to increase the speed of the feeder it is necessary to divert gathers into two or more machines and this involves a distributing and conveying system between the feeder and the machine. This, of course, increases the rate per unit but it compels the use of troughs and slides and deflecting devices, all of which tend to injure the quality of the product, and the high speed of course limits the orders to those of greater quantity than is possible with the individual feeder.

The mold expense increases per unit and, while molds vary in cost, they probably average around $100 per mold for the complete sets necessary for a modern semi-automatic machine, and this gives a pretty definite way to figure just what size order is necessary to reduce mold expense to a reasonable point.

STANDARDIZATION OF WARE

As is well known, there is a very great variety in the size, style and kind of glass required by the consumer of bottles, who is not interested in the purchase of bottles as such, but because they are the proper package for his primary product, and this limits standardization of bottles.

One would not think of selling high grade perfumery in a small beer bottle no matter how attractively it was labeled.

Again, firms making some special highly advertised product like to have the shape and character of their bottle distinctive, so as to connect the bottle, as well as the name, with the article.

Glass has advantages in being clear and showing up the nature of the contents and this favors high grade products, and the use of paper labels destroys this advantage, so that

the use of identifying names blown into the bottle is very common.

In the past few years, when bottles were very scarce, almost any kind had to be accepted and this period was a good time to effect standardization, but this movement gained very little headway in spite of that.

The only inducement for users to give up bottles of a distinctive and individual type and accept a standardized package is the matter of cost, and it requires a considerable differential to justify this, so that with reduction of costs by individual feeders and bringing these costs nearer to that of standardized ware, coupled with the advantages of distribution from a plant able to fill orders of many styles of bottles, the future should show a greater tendency toward the individual bottle than toward the standardized bottle.

The average bottle manufacturer has built up a line of product, a line of customers and the requisite knowledge to make these particular kinds of bottles, so that in considering the feeder question the average man will look for a feeder which fits into his conditions rather than for a feeder which compels radical changes in his factory equipment, his management and personnel, his selling arrangements, etc., so that for a great many, probably the greater number, the individual feeder occupies a place that is sound fundamentally.

On the other hand, to those who contemplate mass production with few kinds and with large orders, the high speed feeder will appeal by reason of its lower cost per gross.

Just what is best involves so many factors and conditions that the problem is far from simple, and in an article of this kind one cannot attempt to set any definite rule, but the problem should be considered very carefully in order to reach the right solution.

COSTS

A word as to costs: In the old blowpipe or hand shop method, the fabrication of the bottle at the ringhole was the large item of expense, in fact, overtopping all the other costs combined. There was no power plant and overhead and fuel costs were extremely low, so that the variation of production did not so materially change the cost per gross of product. As machinery began to enter the industry, requiring central power stations, cost systems, selling departments and large overhead, the question of production became the pertinent one. If a factory operated at half capacity the total expense was not greatly reduced, but the cost per unit of product was greatly increased. This made the field for the automatic feeder. The uncertainty of profitable production and lost time also brought another differential in favor of the feeder, which amounted to a large item in a year's time.

The work of the gatherer was dependent upon his strength and skill and habits, and these human factors were out of control of the owner. The question of evenness of weight also depends upon this factor. Again, the traditions of the glass worker made the shutting down of shops for holidays and for sickness of one member of a crew a very troublesome question. This last matter does not affect the question with a feeder theoretically so much as it does practically, as is known to every manufacturer. The absence of a carrying-in boy, for instance, usually put the whole shop out of commission.

With the feeder and a carrying-in boy absent, theoretically the same thing would happen, but it seldom does, as every effort is made to take the ware in when it is known that it will be made, except for the simple operation of conveying it to the lehr. Thus the average stops with feeders from this source are much less than with the hand shop.

With hand, maximum production is far greater than average production, but with the feeder, maximum production is practically average production, as it is set to run at the highest point and kept at that speed.

This feeder proposition boils down to one significant figure: How many bottles per minute per ringhole are packed, covering a month's average, figuring in the time that furnace is in operation and ringhole supposed to be working. In hand fed operations this figure seldom exceeds five per minute, while with feeders under the same conditions, that is, both feeder and hand feeding pushing the machine to its limit, the average in good practice runs from nine to eleven. It does this at a lower wage cost, of course, and thus with a doubled capacity, or practically so, and lowered wage cost, it is not hard to see that the wages of the gatherer have little to do with the problem. These figures apply to the usual form of hand gathered semi-automatic machine on average sized ware.

MONOPOLY CONTROL

The trade generally is at present concerned over attempts to monopolize the industry and put it into a few hands, and the present tendency is that way.

The writer's belief is that this is a stage of evolution in the industry which is very beneficial. The nature of the business is such that a monopoly or close control is almost impossible, owing to the various factors discussed earlier in this article.

The reason why certain large corporations have been forging ahead so rapidly has been due largely to the manner in which the small factories have conducted their business. Poor locations, cheap, flimsy constructions, poor management, almost total disregard of any scientific merchandising and various allied evils have done more to give the opportunity to the large centralized, well managed, well financed corporations than any particular advantage in automatic equipment.

The smaller progressive manufacturer today is keenly alive to this condition and is anxious to remedy it, and the tendency toward monopoly will act, as it always has, as a spur to greatly increased efficiency by the small manufacturer who has obviously many advantages over his large centralized competitor.

It is the old story of evolution and survival. It is the story of the diplodocus and the mouse, the department store and the corner grocery, carried into the industrial field, and it is an old story even in the glass business in this country. This story has been told in the plate glass industry, in the window glass industry and now it is being written in the bottle industry, but the answer has always been the same.

Many plants will go out of business but many more will reach a stage of efficiency that they would never have known had it not been for fear of annihilation by the large centralized plant. Combinations of smaller plants will effect some

of the advantages of large organizations while retaining the advantages of the smaller unit.

PATENTS

No consideration of the feeder situation is complete without including the subject of patents.

During twenty-five years several hundred patents have been issued covering this activity and the basic patents have either expired or have a short time to run.

The Patent Office is full of applications and many old impracticable applications have been bought up, refurbished, claims added, etc., and are the cards with which this interesting game of industrial poker is now being played.

Space forbids a minute analysis and we can give only broad conclusions.

1. There are at least four general systems that are practical for commercial feeders.
2. That for each there are many different ways of operating these systems.
3. Patents are monopolies or plums given to inventors as inducements for useful development.
4. The use of old, impracticable patents for suppression of useful development is against the primary object of patent law.
5. Decision rests with judges sitting under equity rules and with their training and viewpoint along equity lines.

Looking at it in a broad way one must conclude that inventive activity will be encouraged, suppression of activity discouraged, the flexibility of judicial decision will be sufficient to substitute for needed legislation, to prevent taking the specific accomplishments of the inventor or to prevent stretching patents to stop independent useful accomplishment.

Governing this as well as all lines of human activity is the law of compensation which is as immutable as the law of gravity.

There will be innumerable infringement suits, interference proceedings, etc., and in specific cases these will compel changes and call upon the versatility of inventors, but one cannot intelligently conclude that any scheme of suppression or monopoly will be successful in this situation any more than the schemes of Napoleon or the Kaiser who had the same object and ran against the same immutable laws of evolution.

FUTURE

What of the future? The writer is not a prophet, but certain things point very clearly to the future development of the feeder.

Mechanical production of bottles is here to stay and will eventually be the means for all but a negligible per cent of total output.

In the smaller individual feeder, flexibility and quality of ware will probably be the leading lines of development.

In the fast, or high production, feeder the troublesome and unnecessary distributing operation will be abandoned and the multiplicity of machines which start and stop as each bottle is made will be replaced by a direct fed continuously moving bottle machine, eliminating vibration and also giving a speed limited only by the number of molds employed.

The writer believes that the relative positions of the feeder and the Owens type of machine will, with development, increase in the direction of the feeder. He also believes that as the Owens machine held the lead for a number of years, so the feeder principle will be the predominant factor for a few years, but not for as long as the Owens period; that the contributions of science and mechanics and invention will eliminate the many steps now necessary in either the Owens or the feeder process, and that the bottle making of the future will be on a system eliminating the basic principle of both feeder and Owens systems, and that this system will be a quality system, a simple system and one combining flexibility and efficiency. Work on such a system is already under way and some actual and successful experiments in glass have been conducted, but this will be a work of years and another chapter.

[EDITORIAL NOTE.—The author of the foregoing article has raised a number of interesting points concerning which further discussion is invited from any one interested in bottle manufacturing, automatic machinery, or any other phase of the subject.]

The Fluorspar Industry in 1919-1920*

By HUBERT W. DAVIS and RAYMOND B. LADOO

SHIPMENTS: The fluorspar shipped from mines in the United States in 1920 is estimated to have amounted to 186,000 short tons, valued at $4,544,000, as compared with 138,290 short tons, valued at $3,525,574, in 1919. These figures show an increase in quantity of 34 per cent and in value of 29 per cent. The shipments in 1920 are about 29 per cent less than the record of 263,817 in 1918, reached under war demand, but are greatly in excess of the pre-war record of 116,545 tons in 1912.

The general average value per ton f. o. b. mines or shipping points for all grades of fluorspar in 1920 was $24.43, which is $1.06 per ton less than the average value reported in 1919. The highest average value reported in 1920 was recorded in Kentucky, which was about $27 per ton, and the lowest in New Mexico, which was about $17.66 a ton. It should be noted that the differences in the average values reported do not generally represent differences in quality but differences in freight rates from the mines to the consuming centers, the values given being f. o. b. shipping points. Quoted prices on gravel spar were somewhat lower than in 1919, the price of 85 per cent grade ranging from $22.50 to $27 per ton in the Kentucky-Illinois district. Acid lump spar was greatly in demand at prices from $50 to $60 per ton. The base price of gravel spar for 1920 was reported to be about $5 lower than 1919.

IMPORTS: The imports of fluorspar into the United States during 1920 amounted to 24,610 short tons, valued at $265,624; in 1919 they were 6,943 short tons, valued at $107,631. The value at the foreign ports of shipment assigned to the imports for 1920 averaged $10.79 a ton; for 1919 it was $15.50 a ton. The imports for 1920 are greater than in any year since 1913, when they were 22,682 short tons.

*Co-operative Report, United States Geological Survey and United States Bureau of Mines.

Annual Meeting of the American Ceramic Society

Large and Successful Gathering at Columbus, Ohio, February 21-24, 1921. Interesting Papers Read at Glass Division Meeting

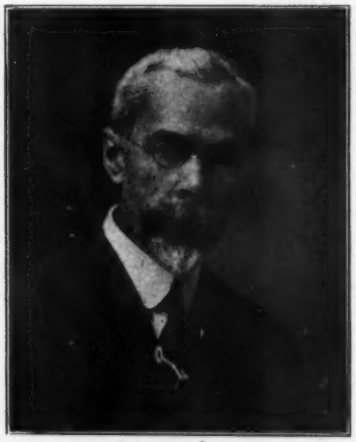
By A. L. BROWN*

The twenty-third annual meeting of the American Ceramic Society, held at the Hotel Deshler, Columbus, Ohio, February 21-24, brought together over 300 of the society's 1,300 members, many of whom had travelled long distances in order to meet old friends, enjoy the social activities, discuss the problems and progress of the industry and listen to the interesting and instructive papers presented to the divisions relating to glass, refractories, enamels and terra cotta and other branches of the ceramic industry. Over one hundred papers were contributed by engineers, chemists and technical workers from all sections of the country. Quite a number of ladies were present. At the conclusion of the meeting Prof. Binns said: "It was the best meeting ever held. About 400 registered, and next year we expect 500. All through the convention there has been a very live spirit, the problems are very interesting, thorough and educational."

Starting on Monday, February 21, a business session was held. The address of the retiring president, R. H. Minton, was delivered, the report of the Board of Trustees was read by Prof. Charles F. Binns and other business was transacted. In the afternoon at another session papers of general interest to all branches of the ceramic industry were read. On Monday evening a smoker, under the auspices of "Section Q" was greatly enjoyed.

THE NEW PRESIDENT F. K. PENCE

THE RETIRING PRESIDENT R. H. MINTON



CHARLES F. BINNS, Re-elected Secretary.

R. K. HURSH, Re-elected Treasurer.

R. M. HOWE, Newly-Elected Trustee.

On Tuesday the several industrial divisions of the society met separately, and many important papers were read and discussed. In the evening the society's annual dinner took place, with Prof. Edward Orton, Jr., as toastmaster. There were 260 present, a record for the society. The speakers were R. C. Burton, Forrest K. Pence, Dr. E. W. Washburn and W. E. Gates. The latter, a former president of the society, is one of its oldest members.

On Wednesday afternoon, Feb. 23, the election and in-

*With Charles F. Long, Consulting Chemical Engineer, Columbus, O.

stallation of officers of the society took place. The retiring officers were:

President—R. H. Minton, General Ceramics Co., Metuchen, N. J.

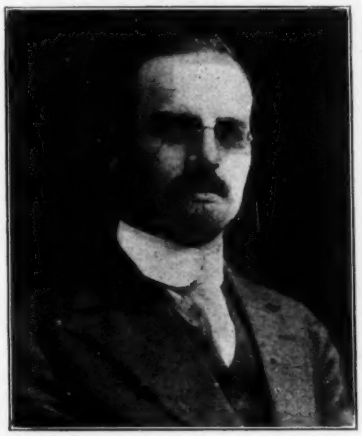
Vice-president—E. T. Montgomery, Montgomery Porcelain Products Co., Franklin, O.

Secretary—Chas. F. Binns, New York School of Ceramics, Alfred, N. Y.

Treasurer—R. K. Hursh, University of Illinois, Urbana, Ill.

The officers elected at this meeting were:

President—F. K. Pence, American Encaustic Tiling Co., Zanesville, Ohio. Mr. Pence is a 1909 graduate of the Ceramic Engineering Division of the Ohio State University. His connection with the American Encaustic Tiling Company began soon after leaving college and at present he occupies the position of production manager for the company.



E. W. WASHBURN, Who Recently Became Editor of the Journal of the American Ceramic Society.

E. WARD TILLOTSON, Re-elected Secretary of the Glass Division.

Vice-president—F. B. Ortman, Tropico Potteries, Glendale, Cal.

Treasurer—R. K. Hursh, University of Illinois, Urbana, Ill.

Trustee—R. M. Howe, Mellon Institute, Pittsburgh, Pa.

Secretary—Charles F. Binns, New York School of Ceramics, Alfred, N. Y.

R. H. Minton will head the Committee on Publications as chairman during the ensuing year.

This year there were three new divisions of the society formed. They are (1) The Heavy Clay Products; (2) White Ware, including porcelain, china, insulators, etc.; (3) Ceramic Art, including design and decoration. The officers of these divisions are:

(1) Heavy Clay.
R. C. Purdy, chairman.
C. Forrest Tefft, secretary.

(2) White Wares.
A. V. Bleininger, chairman.

(3) Ceramic Art.
Fred W. Rhead, chairman.
Mabel C. Farren, secretary.

Following the meetings visits were made on Thursday by some of the members to industrial plants and various points of interest in Columbus, including the Ohio State University, where the first school of Ceramic Engineering was established in 1894 by Prof. Edward Orton, Jr. Since then four other schools have been founded. The demand for ceramic engineers increases yearly at a faster rate than the schools are able to supply graduates.

No action was taken during the convention relative to the standard specifications for lime and limestone recommended by the Bureau of Standards.

A proposal to appoint a paid secretary who should give all of his time to the society's interests was rejected by the board of trustees.

Miss Nora W. Binns, daughter of Secretary Charles F. Binns, had charge of registration and called nearly every one of the members in attendance by name.

A local committee headed by Prof. A. S. Watts had charge of the arrangements for the convention. W. D. Richardson was chairman of the banquet committee. M. B. Cheney was in charge of the smoker, J. F. Krehbiel of the service and equipment, and Mrs. A. S. Watts was in charge of the committee for the entertainment of the ladies.

The Glass Division

On Tuesday, February 22, 1921, the election of divisional officers for the ensuing year was held and the entire list of officers of the Division is now as follows: chairman, W. M. Clark; vice-chairman, J. C. Hostetter; secretary, E. W. Tillotson; and councillors, H. L. Dixon, Charles O. Grafton, E. C. Sullivan and C. H. Kerr.

Vacancies in the various committees of the Society were filled by Glass Division representatives, as follows: Membership, Henry W. Hess, Toledo, O.; Standards, Alexander Silverman, Pittsburgh, Pa.; Rules, R. J. Montgomery, Rochester, N. Y.; Co-operation, W. S. Williams, Pittsburgh, Pa.; Sections and Divisions, J. W. Cruikshank, Pittsburgh, Pa.

A motion proposing a joint meeting of the Glass and Refractory Divisions at the 1922 annual meeting was adopted.

A motion to accept conditionally the invitation to visit the glass factories of England in 1922, extended to the Glass Division by Dr. W. E. S. Turner, secretary of the Society

of Glass Technology of England, during Dr. Turner's visit with a party of British glass men to American factories last year, was carried, and J. W. Cruikshank was appointed a committee to investigate the probable cost of the trip and ascertain how many members would go. A vote of thanks was tendered Dr. E. Ward Tillotson and H. L. Dixon in appreciation of their success in caring for and entertaining the British visitors during their tour of the glass factories last year.

The establishment at some suitable American college or university of a department of glass technology was suggested by Professor Silverman during the presentation of his paper on "The Training of the Glass Works Chemist." The United States, as recently noted* by Dr. W. E. S. Turner of the School of Glass Technology, has no course comparable to the one at the University of Sheffield, where a thorough education in glass technology may be obtained.

Among those who attended the Tuesday session of the Glass Division were:

Name	Business Association	Address
J. S. Herzog	Simpson Foundry & Eng. Co.	Newark, Ohio
C. C. McGruder	Simpson Foundry & Eng. Co.	Newark, Ohio
A. W. Kimes	*National Glass Budget*	Pittsburgh, Pa.
H. G. Willetts	The Willetts Co.	Pittsburgh, Pa.
W. F. Brown	The Libbey-Owen Sheet Glass Co.	Charleston, W. Va.
G. S. Dunbar	The Federal Glass Co.	Columbus, O.
I. E. Adams	The Federal Glass Co.	Columbus, O.
A. L. Brown	THE GLASS INDUSTRY	Columbus, O.
M. T. Holmes	National Lime Association	Washington, D. C.
G. A. Bole	Chemist	Alfred, N. Y.
J. R. Manegold	Dings Magnetic Separator Co.	Milwaukee, Wis.
A. R. Payne	Hazel Atlas Glass Co.	Washington, Pa.
David Stenhouse	Hazel Atlas Glass Co.	Washington, Pa.
F. C. Flint	Hazel Atlas Glass Co.	Washington, Pa.
R. C. Brett	Hazel Atlas Glass Co.	Washington, Pa.
W. J. Knothe	Russell Engineering Co.	St. Louis, Mo.
C. C. Rand	National Lamp Wks.	Cleveland, Ohio
M. A. Smith	McKee Glass Co.	Jeanette, Pa.
J. W. Hosburg		Chicago, Ill.
A. W. Bitting	Glass Container Association	Chicago, Ill.
R. J. Mongomery	Bausch & Lomb Optical Co.	Rochester, N. Y.
J. C. Hostetter	Corning Glass Works	Corning, N. Y.
G. F. Metz	Hardinge Co.	New York City.
R. H. Daughterty	National Lamp Wks.	Cleveland, O.
J. M. Hammer	*The Glass Worker*	Pittsburgh, Pa.
Alex. Silverman	University of Pittsburgh	Pittsburgh, Pa.
C. W. Parmelee	University of Illinois	Urbana, Ill.
W. S. Williams	American Window Glass Co.	Pittsburgh, Pa.
M. G. Babcock	Laclede-Christy Co.	Pittsburgh, Pa.
J. W. Cruikshank	Consulting Glass Engineer	Pittsburgh, Pa.
S. J. Sewell	American Window Glass Co.	Pittsburgh, Pa.
E. W. Tillotson	Mellon Institute of Industrial Research	" "
F. G. Lord	Pennsylvania Glass Sand Co.	Lewistown, Pa.
C. E. Frazier	Simplex Engineering Co.	Washington, Pa.
D. W. Ross	Findlay Clay Pot Co.	Washington, Pa.
J. W. Wright	MacBeth-Evans Glass Co.	Charlestown, Pa.
E. W. Washburn	University of Illinois	Urbana, Ill.
F. F. Footitt	University of Illinois	Urbana, Ill
E. N. Bunting	University of Illinois	Urbana, Ill.
E. F. Collins	General Electric Co.	Schenectady, N. Y.

At the Glass Division meeting a number of papers of special interest to the glass industry were read and discussed; they are briefly summarized as follows:

*THE GLASS INDUSTRY, Vol. 2, No. 1, January, 1921, p. 10.

The Operation of Lehrs

By C. E. FRAZIER, president, Simplex Engineering Company
Washington, Pa.

SUMMARY

The object of this paper was to bring out some of the essential points in the operation of lehrs. As we all know, it is harder to anneal some articles of glass than it is others. The proper treatment depends upon the shape, weight, method of manufacture, temperature of the glass when worked, and size of pieces. There is a difference in the temperature of the mold, the plunger and the glass itself. This difference causes strains and to relieve these strains, it is necessary to bring the temperature of the article up to a point that is higher than the temperature was at the time strains were created, and allow it to remain at this temperature a sufficient length of time to soak through the glass, and then cool it gradually to the point where no more strains can be created by rapid cooling. Experience has shown that the initial temperature of the annealing chamber should be from 800 to 1,100 degrees F. and the time necessary for saturation or soaking is from forty-five minutes to one hour and twenty minutes, depending entirely on the shape, weight and method of manufacture. These factors can only be determined by actual experience with the article to be annealed. Even though the fire box or annealing box temperatures and treatment be correct, said the speaker, the ware can easily be destroyed by improper treatment after it leaves the annealing chamber or fire box.

Experience shows that there should be a drop of 50-75 degrees to each 5 feet of lehr. Another important factor in lehr operation is to watch very closely the flame in the annealing chamber. One is liable to get a false pyrometer reading, especially by a reducing flame where the tip of the flame may strike the pyrometer. Avoid all possible cold drafts that come under the pans and strike the ware. This is sometimes overcome in the open type of lehr by heating the lehr pans from below.

The speaker gave the following conditions as being necessary to the proper annealing of any piece of glass: proper mold design, proper working temperatures, proper temperature in annealing chamber, proper soaking or saturation time and gradual cooling of the ware after it leaves the fire box or annealing chamber. These conditions hold good regardless of the type of lehr used.

As to the size of lehr to use it is best for practically all purposes to use an eight-foot lehr. It is better to use four eight-foot lehrs than three ten-foot, and three seven-foot lehrs than two ten-foot. The length of the lehrs has been a bone of contention. A 65-foot lehr is plenty long enough to use. One company was using an 80-foot lehr and a new 65-foot one was built beside it. It was only a short time until it was proven that the 65-foot lehr was better and, as a consequence, the 80-foot was changed into a 65-foot lehr.

Another important point in the construction of a lehr is the kind of chain to use. On the first continuous lehrs a chain with a working strain of 2,000 pounds was tried, then 2,300 pounds and 3,600 pounds, but the best in practice today is 5,800 pounds at a speed of 200 feet per minute. DISCUSSION: Mr. Frazier was asked whether it made any difference how a lehr is placed with reference to the compass. He replied that unless winds blow directly into the lehr it does not make any difference, how they are placed.

The question was also asked whether pyrometers are essential in lehr operation. Mr. Frazier replied—"Absolutely, yes." The placing of pyrometers is especially important. They should not be placed so that the flame strikes them. Care must be taken to install them at points where correct readings of temperatures at the pans can be obtained.

In answer to another question Mr. Frazier said: "In ten years' time there will be no open type lehr, as the muffle lehr is so much superior to the open style."

The Training of the Glass Works Chemist

ALEXANDER SILVERMAN, Head of School of Chemistry, University of Pittsburgh.

SUMMARY

This was a very interesting paper on the college training of glass works chemists. Prof. Silverman divides the scholastic year into three terms.

The first year's training should be

a—A study of Inorganic Chemistry. There should be a sufficient number of hours for lecture, recitation and laboratory work.
b—Study of Physics for three terms.
c—Study of Mathematics—algebra, trigonometry.
d—Study of German.
e—Study of English.

Courses in the second year should be:

a—Continuation of the study of Inorganic Chemistry as a review. A book on the order of Alexander Smith should be used for a text book.
b—First two terms—Qualitative Analysis should be given. In the third term a course in Quantitative should be started.
c—Continuation of the study of Physics, especially Light, in first term; Heat, in the second and Physical Properties of Glass in the third term.
d—Higher Mathematics, as analytical Geometry and Calculus should be given.
e—Continuation of the study of German, or if enough has been taken, French might be taken up.
f—Graphics should be studied for three terms.

Subjects in the third year are:

a—Physical Chemistry, with lectures, recitation and laboratory work.
b—Quantitative—General in the first term; raw materials in glass manufacture in the second, and analysis of glass in the third term.
c—Gas and fuel analysis should be taken up, together with fuel values and pyrometry.
d—Organic Chemistry, to learn of solvents, structure and uses of organic compounds.
e—Continuation of the study of French.

In the last or fourth year the following is suggested:

a—A study of clays and refractories.
b—Glass Technology—especially furnace control, annealing, manufacturing of all kinds of glassware, manufacturing of enamels and decorating. This should have recitation, lecture and a great deal of laboratory work.
c—Ceramic calculations.
d—Laboratory work on clays and refractories.
e—General Economics—such as factory management, labor, costs and efficiency.
f—At least 5 hours of assigned library work.
g—A short course in Mineralogy with especial reference to raw materials.
h—Chemical Microscopy.

During the summer months of the first two years the student should obtain employment in some glass factory, doing any and all kinds of work such as carry-in boy, turn-out boy or packer, so that he may familiarize himself with a glass factory. In the third year the student, if possible, should obtain a position as a chemist in a glass factory laboratory. This will broaden him to a great extent and together with his college training should make him more valuable to the glass manufacturer when he finishes his college work.

Dissolved Gases in Glass

E. W. WASHBURN, Head, Department of Ceramics, University of Illinois.

SUMMARY

Dr. Washburn explained by use of lantern slides how this method determines the amount and the kind of gases that are dissolved in glass. He likened his experiments to that of opening a bottle of soda water and then determining the amount of carbon dioxide contained in the bottle.

His first experiment was made upon a piece of barium flint optical glass. This piece was put into a suitable electric furnace previously evacuated by nitrogen. This furnace was heated electrically by platinum wire. After evacuation the glass was melted. After melting it was allowed to cool and the gas present was pumped into a cylinder previously evacuated by nitrogen. Here samples were drawn off and analyzed, and results on three samples were found to be:

	(1)	(2)	(3)	Mean
Oxygen	.078	.092	.074	.08
Carbon Dioxide	.017	.023	.031	.02

Results are reported in per cent by weight.

Because of nitrogen being used in the above experiment, the percentage of nitrogen could not be determined, therefore a second experiment was made.

This furnace was made of glass and porcelain, fitted up with delivery tubes, and an attachment for evacuating, and also platinum wires. The glass was melted in the furnace and allowed to cool. After cooling mercury was run in from the bottom, thus displacing the evolved gases. These gases were run into an Orsat apparatus and analyzed. The results shown are on three different samples of glass:

	Volume Per Cent			Per Cent by Weight		
	O_2	CO_2	N_2	O_2	CO_2	N_2
Barium Flint	83	27	1	.035	.011	.000
Light Flint	36	12	1	.015	.005	.000
Borosilicate	45	10	3	.005	.014	.0025

It is believed that if the gases that are dissolved in glass can be removed we will be able to make a higher grade of glass which may be used for many purposes for which glass as now made is not suitable.

The Design and Operation of Glass House Furnaces

F. J. DENK, Consulting Engineer, Pittsburgh, Pa.

SUMMARY

Mr. Denk was not present but his paper was read by J. W. Cruikshank.

Most all furnaces today are made for natural gas with a set of generator chambers for using producer gas. These regenerators are usually built too small. The designers must know about what kind of producer gas the operator may be expected to make if a uniform temperature is to be obtained. The checker chambers should have the following properties:

(1) A heavy wall so as to prevent gas leakage.
(2) Chambers should be insulated.
(3) Should have longer vertical axes.
(4) Should prevent dead pockets.
(5) Should have natural draft.
(6) The air outlet should be flared, so as to prevent dead pockets.
(7) The piping must be so arranged that there is no mistake in gas and air.
(8) The volume must be large enough. Checker chambers are usually built too small.

For efficient operation the vertical area of hearth must be the right size.

It is very necessary to equip the furnace with instruments

and make use of all technical knowledge available upon the furnace, as for example:

(1) Draft recorders should be used; these show up any clogging.

(2) The temperature of the stack should be known as well as the checkers, melting and working ends.

(3) The furnace should be equipped with a platinum-rhodium couple.

(4) Waste gases should be analyzed.

In the discussion which followed, the following points were brought out:

(1) The chamber is made entirely of fire brick.

(2) Silica brick could also be used.

(3) Silica brick are less liable to be attacked by gases.

(4) A 3 x 6 x 18 inch is the best size of brick to use.

Mr. Denk's paper was supplemented with slides showing faulty furnace construction.

Some Chemical and Physical Data on Glass Sands

W. F. BROWN, LIBBEY-OWENS SHEET GLASS COMPANY, CHARLESTON, W. VA.

SUMMARY

The most important chemical determination upon glass sand is the estimation of the iron content. There are usually two errors connected with the determination of iron: (1) The sand is not put entirely in solution or, in other words, the iron is not all dissolved. In the residue after solution there is at times 50 per cent of the iron content still unattacked. (2) The fact that titanium interferes with the determination of iron. It has been found that the per cent of titanium varies, sometimes lower, sometimes equal to and oftentimes greater than the per cent of iron.

No one seems to know the effect of titanium upon glass. Some say it causes a yellowish color, while others say it gives a metallic luster.

Some analyses which Mr. Brown gave on lantern slides are very interesting.

Determinations	Source:	Oregon, Ill.	Ottawa, Ill.
Iron Oxide (Fe_2O_3)		.017	.057
Titanium Oxide (TiO_2)		.017	.021

The size of grains in the sand does not make any appreciable difference as long as the crystals are not too large, providing one becomes accustomed to the particular kind, but in changing over to finer sand after using a coarser one, some difficulty would be encountered.

Mr. Brown emphasized the importance of analyzing and testing glass sands and urged co-operation in compiling and publishing useful data on this subject.

Some Considerations in the Construction and Use of Pot Arches

J. L. CRAWFORD, MELLON INSTITUTE, PITTSBURGH, PA.

SUMMARY

It is very essential that glass pots be burned with great care. The bottom especially must be well burned, because the greatest load is on the bottom. The back of the pot gets the most heat. The wall of the arch should be eighteen inches in thickness, made up with insulated brick, fire and common brick. The door is one very essential item. It should be made heavy and must fit tight. The back walls should be made of fire or silica brick. Pot arch should be of the down draft type so as to give a uniform heat. The stack must be properly designed so as to give the proper draft.

Oil, gas together with compressed air or coal can be used as the fuel. The usual temperature at which the pot is put to use is between 1,800 and 2,000 deg. F. A higher temperature than this is recommended before using. In heating up, a burner should be placed in each corner. In an experiment in heating up a pot it was found by using cones and pyrometers placed at front, back, top and bottom, that there was very little difference in temperature at these points. It is very easy to hold heat in a pot and it is also easy to heat the pot up. It is believed that a single arch is better than a battery. The usual time in heating a pot varies from six to eight days. The pot is heated slowly for two days to 250 deg. F. It is then gradually raised up to around 2,100 deg. F. and held at this temperature for at least a day, but better for a day and a half. One firm has a special building constructed where the pots are stored and a constant temperature is maintained. This heating has saved a lot of money by prolonging the life of the pots.

In presenting the subject Mr. Crawford used some interesting lantern slides.

A Thermal Study of Some Members of the System $PbO—SiO_2$

H. I. SHAW AND B. I. BALL, BUREAU OF MINES, WASHINGTON, D.C.

SUMMARY

This paper showed that mixtures of varying proportions of $PbO—SiO_2$ gave different compounds. Probably they should not be called compounds but solid solutions. Experiments with different mixes showed the following results:

45—52% PbO gave a dull white friable mass.
55—57% PbO gave a vitreous mass.
60—70% PbO gave a yellow mass.
70—80% PbO gave a completely fused mass.
80—90% PbO gave a completely fused brown mass.

Lawton, Ky.	Rockwood, Mich.	Berkeley, W. Va.	Hancock, W. Va.	Thayer, W. Va.
.389	.020	.021	.090	.068
.123	.017	.051	.051	.055

The melting temperature was around 690 deg. C.

It is definitely known that a number of these solid solutions exist as there is a $PbO—SiO_2$; $PbO—2SiO_2$; $2PbO—SiO_2$; $PbO—5SiO_2$.

This is just a beginning of this study. It was made before the war. Since that time the writers of the paper have done nothing further upon the subject. It was presented here with the idea that possibly some one else might have been interested and working upon the same or similar experiments.

An Electrically Heated Glass Annealing Lehr

E. F. COLLINS, GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

SUMMARY

The principle of annealing, as we all know, is to remove strains. This is now accomplished by using as fuel natural gas or producer gas. In the near future, however, we will see electrically heated lehrs.

Electrically heated lehrs should handle twice as much ware as fuel heated lehrs. Electrically heated lehrs are especially adapted for annealing telescopic lenses.

The advantages of electrically heated over fuel heated are:

(1) Very accurate control of the temperature. One should be able to hold the temperature to within 2½ deg. C. very easily.

(2) Time of annealing should be less. It should only require about one-half the time by using electricity.

(3) There are no sulphur deposits upon the ware in the electrically heated lehr as there are in the producer gas fired lehr.

(4) The ware is perfectly clean and sanitary and requires no washing.

(5) The breakage is less in the electric lehr.

(6) The electric lehr will require less floor space.

Basing the cost upon breakage, fuel used, cleanliness, floor space, temperature control, etc., the electric lehr can be operated at 20 per cent less cost than a fuel heated lehr.

An experiment is now being carried out to show the life of an electrically heated lehr. A ribbon of No. 2 nichrome wire is used, and the temperature is kept at a very constant high point; the result is very good, no damage to the ribbon can be noticed in three months' time.

Illuminating Glassware Manufacture

WARD HARRISON, Illuminating Engineer, Cleveland, O.

SUMMARY

Mr. Harrison presented a paper illustrated by lantern slides which showed faulty construction in bulbs and reflectors used for lighting purposes.

Manganese dioxide present in glass will cut down the per cent of light, especially in street lighting. Pure white glass is the best to use to get the most efficient light. The construction of reflectors and globes also has a great deal to do with the amount of light obtained. It is suggested that the reflectors be made of rather heavy glass, especially on the top, while the globe itself should be made of a thinner glass. A pure white color is to be preferred over a grey or any light colors. Crystal glass with enamel tops as reflectors are going to be more popular in the future.

Mr. Harrison pointed out the need of better co-operation between the glass manufacturer and the illuminating engineer.

Composition of Barium Glass

R. J. MONTGOMERY, BAUSCH & LOMB, OPTICAL COMPANY, ROCHESTER, N. Y.

SUMMARY

Glass containing barium is mostly used for optical and photographic purposes. When using barium there is a very complex glass formed, composed of boric acid, RO bases, zinc, alkalies and barium.

It has been found that as the amount of barium increases the index of refraction goes up. The amount of barium up to 40-45 per cent causes a gradual rise of the index of refraction but above 45 per cent barium the index of refraction does not change.

Legal Notes

By ASHER BLUM*

The Mechanical Production of Window Glass

In the case of the Window Glass Machine Company against the Consolidated Window Glass Company, the Pennsylvania Window Glass Company, and the Kane Glass Company, reported in 261 Federal Reporter 362, the Circuit Court of Appeals for the Third Circuit, which has appellate jurisdiction over the States of New Jersey, Pennsylvania, and Delaware, has upheld very broad claims covering the mechanical production of window glass in U. S. Patents No. 702,013; 702,104; 702,015; 702.016; 886,618; 1,020,920; 762,880; 822,678; 914,586; 821,361; 822,452; 1,006,995; and 1,020,920.

The Court found that these patents were a great pioneer step, "which gave to a machine and a mechanical process the equivalent of the fine skill of the most skillful of artisans."

As illustrating the fact that it required far more than ordinary ability to create these patents, the Court went into the history of the manufacture of window glass and found that it formerly had been absolutely dominated by a small body of skilled artisans whose labors often caused physical decline. The grip of labor organizations and the chaotic condition of hand manufacture were considered in estimating the benefits produced by the inventions concerned.

The Court visited a factory and the opinion states that the production of a huge glass bait or cylinder, 38 feet in height and 38 inches in diamater, was "a real, veritable miracle."

Hence the Court sustained very broad claims, such as the use of an air supply pipe to equalize pressure in the article drawn; the idea of gradually increasing the speed of drawing so as to shape the glass; the idea of drawing the cap or end of the glass cylinder very thin so that it could be easily separated; the idea of making the bait adjustable in lateral directions so as to have the glass of uniform thickness; the use of a tool made of a small electrically heated wire which could encircle the cylinder to enable it to be broken by tapping with a cold steel tool, etc.

The Court invalidated what were known as the Lubbers "pop valve" claims covering the use of valves to allow air to escape from the glass cylinder when the pressure rose too high.

These patents and in addition, Nos. 890,306; 914,588; 1,176,505; 926,501; 1,073,613; 1,176,505; 1,102,803; and 841,011 were again considered in the action brought by the Window Glass Machinery Co. v. Smethport Window Glass Co. in 266 Fed. 85 by His Honor, Judge Thomson, sitting in Pennsylvania.

The Court found no new defenses against the claims previously held valid and hence it upheld them and found that nearly all of them were infringed.

Hence, unless some entirely new defenses are found by another litigant, the Window Glass Company has very broad protection for many years. It is possible that if any defendant located outside of the Third Circuit, is sued, that some other Circuit Court of Appeals may not agree with the opinion in the Third Circuit, but such disagreements are rare, especially in complicated cases involving intricate considerations.

*Of Mock & Blum, patent attorneys.

Effecting Change of Glass Composition in Tank Furnace

The Rate of Change of Glass Composition in a Tank Furnace Following a Change in the Batch Composition *

By JOHN CURRIE, M. A.†

It is known that when any radical change is made in the composition of a batch fed into a glass melting tank time must elapse before the new composition is thoroughly established in the working end of the tank. How slow this process is, however, is not generally realized. The experience of the author, who followed the progress of the change may be of interest to glass manufacturers.

The tank furnace in question had a dead weight capacity of 106 tons. During six working days in the week filling on takes place every two hours, the quantity added in each charge being made up of 30 cwt. of batch and 4 cwt. of cullet derived directly from the working end. The metal in this tank contained a fairly high percentage of lime, being used for bottles made on Forster machines. Semi-automatic O'Neill machines with Hartford-Fairmont feeder were installed in place of these, and it then became necessary to produce a glass of lower melting point and slower rate of setting. With this end in view the batch was altered so as to reduce the percentage of lime, at the same time increasing the percentage of alkali in the glass.

The batch originally in use with the Forster machines was as follows:

Sand	1,000 parts	Salt-cake	133.3 parts
Limestone	400 "	Soda-ash	133.3 "

The glass obtainable from this batch would have the following theoretical percentage composition:

SiO_2	67.64	CaO	11.95
FeO	2.69	MgO	1.72
Al_2O_3	4.16	Na_2O	11.84

The new batch was made up of—

Sand	1,000 parts	Salt-cake	133.3 parts
Limestone	200 "	Soda-ash	166.6 "

giving a glass the theoretical percentage composition of which would be:

SiO_2	71.28	CaO	6.78
FeO	2.42	MgO	1.29
Al_2O_3	3.96	Na_2O	14.27

This new batch was put into use on the 20th of November, 1919, and on the various dates mentioned thereafter a sample bottle was taken for analysis. The density of the glass was also determined, as shown in the table, and it is interesting to compare the gradual decrease in density of the glass with the varying composition.

The results are as follows:

	Percentage Composition of the Glass						Density at
Date	SiO_2	FeO	Al_2O_3	CaO	MgO	Na_2O	15.5°
Nov. 20th.....	66.20	2.60	4.45	12.11	1.84	12.80	2.597
" 25th.....	66.74	2.61	3.95	11.43	1.83	13.44	2.588
" 28th.....	67.25	2.50	4.44	11.03	1.77	13.01	2.579
Dec. 3rd.....	67.40	2.14	3.61	10.32	1.67	14.86	2.568
Dec. 5th.....	68.28	2.13	3.90	10.30	1.70	13.69	2.567
" 6th.....	67.84	2.13	4.32	10.28	1.75	13.68	2.565
" 11th.....	68.89	2.02	3.78	10.00	1.47	13.84	2.563
" 16th.....	69.42	2.13	3.80	9.38	1.37	13.90	2.546
" 18th.....	69.29	2.37	4.17	9.18	1.34	13.65	2.545
" 22nd.....	69.55	2.37	3.70	9.37	1.37	13.64	2.543
" 24th.....	69.39	2.36	3.93	9.38	1.36	13.58	2.541
" 29th.....	70.42	2.24	3.38	9.02	1.47	13.47	2.541
Jan. 6th.....	70.38	2.13	3.20	8.59	1.18	14.52	2.536
" 12th.....	71.00	2.12	2.58	8.09	1.05	15.16	2.521
" 17th.....	70.56	2.11	3.88	7.65	1.33	14.47	2.520
Feb. 2nd.....	71.14	2.11	4.05	7.43	1.36	13.91	2.519
" 16th.....	71.27	2.21	4.50	7.42	1.42	13.18	2.518

It will be observed that after the lapse of almost three months the composition of the glass obtained was nearly, but not quite, identical with that calculated from the new batch, the percentage of lime being 7.42 as compared with 6.78 in the theoretical composition.

The progress of the change was not followed beyond this point, but the main fact established, in this particular case at least, is that a period of nearly three months was required to effect a radical change in the composition of the glass in the tank. The time occupied in bringing about the change will naturally depend upon the dead weight capacity of the tank and the rate at which it is worked, but both of these in this case are about the average for bottle glass tanks in this country.

In passing, it might be mentioned that in this run with Hartford-Fairmont feeder and O'Neill machines one of the chief difficulties encountered was due to the separation of crystalline calcium silicate in the metal at the fore-hearth. Frequent stoppages for various reasons, including repairs to the feeder, led to a lowering of the temperature at the working end of the tank. Subsequent re-heating in the fore-hearth by means of a blast of town's gas caused this devitrification to take place there, and, once formed, it was very difficult to eliminate, being at times quite as pronounced towards the end of this run when the lime content was low as it was at the beginning when lime in the glass was 10 or 12 per cent. Nevertheless, with a glass sufficiently low in lime and correspondingly high in alkali, a combination of this kind for bottle-making should be eminently successful, provided that fluctuations in working temperature are at all times avoided.

DISCUSSION

Dr. Travers said this was a very interesting paper, and recorded what to him was a very surprising thing. He thought that more information about the cullet, the tank depth, and general dimensions of the furnace were required in order to be able to understand this slowing-up of the change.

*Jl. Society of Glass Technology, December, 1920, Vol. IV, No. 16, pp. 382-387.

†Scottish Central Glass Works, Ltd., Kelliebank, Alloa.

He hoped Mr. Currie would give all the data to enable full use to be made of the paper.

Mr. R. L. Frink would like to know if the changes in the batch were made at different periods. Unless it were known how rapidly the soda-ash was increased, it was very difficult to form an opinion as to whether the flow of the glass through the furnace would be retarded by the old metal.

Dr. Travers pointed out that, from the paper, the change of batch was made suddenly. Continuous change was made only in the cullet, not in the batch.

Mr. Rees said that so long a period as three months to complete the change in the batch at the working end was altogether extraordinary, even for a large tank. There must be some other factor at work in connection with cullet used or something which would explain the extraordinarily long time for the change. Particulars of the furnace might help to make the problem clear.

Mr. Guy Simpson said there was one other important question, namely, as to whether the tank was an open tank or one with a dog hole. Further, was the metal dark or light? The batch would take less time if the tank was open; in a bridge tank, it would take longer.

Mr. J. H. Davidson asked how the samples were gathered and from what depth was the metal likely to come.

Mr. A. E. Hill said there was another important point, namely, the stock of cullet held. If there were large stocks of cullet in hand of the old formula, and if these were used in rotation, it would naturally take longer than if the stocks were low, so that most of that used was taken from the working end.

Mr. Teisen would like to know whether the tank was supplied with a floating bridge or a syphon.

Dr. Turner said that when he first began to observe phenomena connected with some tank furnaces which could only be explained by the slow rate at which the metal composition changed, he himself had been astonished. But he had now met several similar cases. He was very pleased when he came across an instance of a chemist in charge of chemical operations who had actually taken the trouble to follow the course of the change in the special circumstances under which the tank was working.

In reply to some of the questions raised, he would say that the amount of batch filled on in two hours was 30 cwt. with 4 cwt. of cullet, so that less than one-eighth of the total weight filled on was cullet. Therefore the question of cullet was less important than had been inferred. The amount filled on in two hours would also give some idea as to the rate at which the glass was worked out of the tank. Mr. Frink asked if the change was made all at once, or if the amount of soda-ash was increased gradually. The change was made all at once. At a certain date the old batch was discontinued and the new batch as such in its anticipated final form was charged. Next, so far as the amount of cullet in stock was concerned, Mr. Currie would no doubt reply to that. In his paper Mr. Currie stated that the cullet used was that taken out of the working end of the furnace as the change proceeded. The samples were taken in just the ordinary mode of working, that is to say, by surface gathering. The samples were not simply dips of metal, but were taken in the form of a finished bottle, and the glass of this bottle was analyzed.

There was just one other thing he (Dr. Turner) would like to direct attention to, namely, the somewhat variable rate at which the proportion of the soda present changed. Already, on the first trial, the percentage was one unit higher than calculated for the glass, and on December 3 actually it distinctly exceeded what was anticipated as the final soda content. Somewhat similar variations took place with the samples taken on January 6 and 12. He would like to know how the batch was mixed, whether by hand or by mechanical means. He had so often had to emphasize the necessity of thorough batch mixing that probably these somewhat irregular figures for the soda were also due to imperfect batch mixing, and might provide an illustration of how the composition of the glass might be distinctly different from that anticipated if thorough mixing was not ensured.

Mr. Currie (*communicated*) stated that he was gratified to know his short communication had aroused so much interest. He had much pleasure in supplying the following information in reply to questions raised.

The tank measured 25 feet 9 inches long and 15 feet 6 inches broad in the melting end. The working end was approximately semi-circular, the radius of curvature being about 7 feet 9 inches. The bridge separating the two compartments was a fixture, being 3 feet broad, and having a dog hole about midway across on the level of the tank bottom. The dog hole measured 16 inches high by 12 inches broad.

The metal, as evidenced by the percentage of iron oxide it contained, would be described as dark metal.

The temperature in the melting end varied from 1300° to 1400°, whilst at the working end it was about 1200°.

The stock of cullet in hand prior to making the change of batch was about 20 tons. This was all used up at first, after which the cullet was taken directly from the working end of the tank. He would add that the total charge of batch fed into the furnace between November 25, 1919, and February 17, 1920, was 1,257 tons, and of cullet 179 tons. The amount used varied somewhat from week to week, usually ranging from about 95 to 110 tons.

As the Hartford-Fairmont feeder was in use, this implied that the metal was maintained at all times at a constant level, being 3 feet deep in the tank. If it had been possible to work the tank down by 5 or 6 inches at the end of each week, as happened in most tanks where hand-gathering was practised, then the change, no doubt, could have been effected in less time. Then, again, the fact that the new metal was of less density than the old prevented rapid diffusion from taking place. A converse change from low to high lime content would, no doubt, take place in much less time.

As regards the variable soda content, this happened because the salt-cake used was frequently very lumpy, and although the batch was mixed by machinery, the metal as it melted was not always of uniform composition.

It would also be observed that the alumina content was somewhat erratic. This was accounted for by the fact that the sand used varied considerably in composition.

MARVELS OF THE GLASS-BLOWER'S ART

Models of Marine Animal Life made for the American Museum of Natural History, New York

GLASS lends itself better than any other substance to the making of such models as are depicted here. The American Museum of Natural History at New York has a wonderful collection of glass models, made by the Museum's glass modeler, Herman Miller. With no other implements than a jet of gas flame, a pair of forceps and a carbon pencil, Mr. Miller evolves from a few pieces of glass rod or tubing many beautiful, interesting and scientifically correct models of flowers, plants, insects and other objects.

Some of the remarkable effects produced by Mr. Miller are shown in the group of models of marine life in the upper picture, illustrating on an enlarged scale the simplest forms of animal life many of which, however, when magnified show relatively complex construction, which must have taxed the modeler's ingenuity to reproduce. This is especially true of the *Radiolaria*, which belong to the protozoa, or so-called one-celled family and manufacture for themselves siliceous, or glass, skeletons similar in composition to opal.

The four large models shown in the photograph represent tiny sea animals which, taken from left to right, enjoy the following jaw-breaking names: 1. *Tholspira* (magnified 300 times). 2. *Lithocircus* (magnified 500 times). 3. *Colozoum* (magnified 100 times), and 4. *Trypanosphaera* (magnified 200 times).

Three different stages in the production of a glass model of a flower are shown in the lower pictures. After heating the middle part of a tube in the gas jet, the two ends are drawn out, bringing the glass to a fine thread. This thread is then broken off leaving the glass in the form of a hollow rod with a bulb on one end. The next step is to re-heat the bulb and blow it out to the desired size. Then the bulb, while still soft, is broken through at the end and the opening enlarged by means of a carbon pencil with which, as illustrated, the glass can be made to assume the general shape of the flower. By carefully manipulating the glass before the flame almost any desired form can be obtained.

Colored Glass

Translated for THE GLASS INDUSTRY BY J. B. KRAK

The problem before every glass manufacturer at the present time is to reduce costs. There are, of course, certain limits. Costs can be diminished by making the batch as soft as possible, in order to reduce the time necessary for melting. The manufacturer can do this only within certain limits, as the resistance against physical and chemical action diminishes when a small amount of lime is used. The problem is to widen the limits as much as possible. Everything which has been tried in this respect has entailed defects which nullified any advantages obtained.

It has been suggested to use alkalimetasilicates instead of alkalies. Their use has several advantages over the application of alkalitrisilicates, because they are lower in price and because sodium metasilicate contains about 50% sodium oxide, potassiumetasilicate about 61% potassium oxide. Another advantage is the fact that they are very pure. When these metasilicates are used it is necessary to remember that they already contain silica. The following quantities replace one another:

115 sodium metasilicate replace 100 parts of soda
112 potassium metasilicate replace 100 parts of potash
86 sodium metasilicate replace 100 parts of salt cake

A mixture of 100 sand, 35 soda ash, 15 lime would be replaced by 80 sand, 40 sodium metasilicate and 15 lime.

As an opacifier, tin oxide is most generally used, although many others exist, such as phosphates of the alkaline earths and titanic acid. The former do not give a sufficiently dense white, and the latter often causes brown-colored spots. Pure zirconium oxide can be obtained at one third of the cost of tin oxide[1] and is said to give excellent results. Other opacifiers used are kryolite, feldspar, fluorspar, calcium phosphate and antimony. The action of these substances is based on the fact that they do not dissolve entirely in the liquid glass, or that they separate out on cooling. Borax, when fused with oxides of tin, lead, titanium, zirconium or thorium, dissolves these substances to colorless glasses, if sufficient fluxes are present. If silica is present, also, the solubility of these elements is increased. If the liquid glasses are allowed to cool, while exposed to water or acid vapors, they become opaque on account of the formation of double compounds of boric acid. These substances separate as very fine, amorphous masses, and permeate the glass evenly. The best way to manufacture such opaque glasses is to melt the boric acid compound of one of the above-named oxides, in such a proportion that a saturated melt is formed. During cooling, water or acid vapor is led over or through the molten glass. The opaque mass is then added to the batch. The opacity thus obtained is very even. The procedure is more economical than the usual one with tin oxide.

Although it has been known for a long time that carbonaceous matter, such as coal, charcoal, wood, wheat and molasses, has the property of coloring molten glass red, carbon is rarely used for this purpose. This may be due to the fact that certain disadvantages are connected with the use of these materials. Lignite and peat show less disadvantages than ground coal, and are used to some extent. If, however, carbon is used in pure condition, such as soot, the results are excellent. Soot gives a deep, warm, red color, causes no seeds and has a coloring power almost nine times as strong as manganese.

An older method to impart a red color to glass is the use of selenium. It is added to the batch before or during the melting process and followed by a reducing agent. It is introduced in combination with sodium, potassium, potassium cyanide, etc. Through a combination of selenium, with selenium compounds of gold, silver, metal oxides, bone ash, kryolite, feldspar, fluorspar, and other coloring agents and opacificers, numerous shades can be produced. Another series of beautiful new colors can be obtained by the reduction of selenium compounds and copper, uranium, chromium and iron by suitable reducing agents, such as arsenious acid, sodium or potassium arsenite, or sodium sulphite. To obtain an orange color, a mixture of selenium and cadmium sulphide is used. The color becomes more and more yellow in proportion to the amount of cadmium sulphide used.

To obtain a deep red color in cathedral glass, copper salts are added. For rose red, gold salts are used, which are easily reduced by heating. After allowing the sheets of glass to cool, they are painted with a mixture of pulverized basalt, potash, saltpeter and calcined borax, made into a paste with water. After drying, the sheets are heated again until the glass becomes soft and the mixture melts. Cathedral glass can also be made as follows: After taking an amount of molten glass on the end of a blowpipe, it is dipped into a paste made of sand, powdered marble and ground glass. This mixture is evenly spread over the molten glass. The blowpipe is then dipped in the liquid glass in the pot and subsequently in the paste. The pipe is dipped for the third time in the glass, and it is then blown into an iron mould, having irregular figures on the inside. The powdered material causes a large number of small seeds, or remains in its original condition throughout the glass. Due to difference in refraction of the light rays, the color is rendered brighter and more attractive, while at the same time the direct transparency is diminished, which is desirable for church windows.

In order to make opaque glass, fluorides or silico-fluorides of tin or cerium are added. The amount differs from 5-25%, depending on the degree of opacity desired. The effect obtained in this way is extremely permanent during further working of the glass. A beautiful and permanent opacity is obtained by using metallic aluminium powder. As small a quantity as 1 part to 1,000 parts of sand is sufficient to obtain opaque or milk glass, which on reheating never becomes transparent. Acid alkali fluorides can be used for the same purposes. This material is added to a batch consisting of sand, chalk, china clay and soda ash.

A batch made up of sand, lead oxide, borax, potash, saltpeter, potash, tin oxide and a small amount of silver nitrate yields a marble glass. If this glass is covered in certain places by reducing substances, the marble veins appear only where desired and the remaining parts retain their original color. Marble glass can also be made by using a pot divided into two parts by means of a wall, having three rows of holes of a diameter of about 1 cm. (0.39 inch). One of the divisions contains opal glass, the other a colored glass. The whole pot is heated, but the glasses do not mix during the melting process. When the opal glass is worked, the colored glass is drawn at the same time. In this way the effect of marble is attained. The composition of both glasses must be such that their expansion and contraction are equal to prevent the cracking of the objects.

Dark glasses can be made by using the ashes of lignite and peat. The ash is stirred into water, contained in a high vessel, and allowed to settle. The ashes are then deposited in the ratio of their specific gravity. First a mixture of iron oxide and lime settles (sp. gr. 3.10), then a mixture of sand and alumina (sp. gr. 2.05), and finally the magnesia compounds (sp. gr. 1.74). The latter are drawn off and used for other purposes. Then the mixture of sand and clay is removed and the clay separated. The remaining substances, namely, sand and a mixture of iron oxide and lime, are mixed with the proper amount of soda ash, and yield a dark glass. For the preparation of ash from peat and lignite, the necessary equipment is indispensable—the above directions are only explanatory of the process.

[a] *Diamant*, vol. 42, p. 547-8, 566 (1920).

[1] This, of course, refers to conditions in Germany at the time of writing.

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NEW YORK, MARCH, 1921

Co-operative Research in Glass

At the annual meeting of the Glass Division of the American Ceramic Society in Philadelphia in 1920, a discussion was initiated by Dr. H. E. Howe of the National Research Council, on the advisability of co-operative research on fundamental problems in glass technology, and a committee was appointed to consider the question. To assist in formulating plans for initiating this important work, the chairman of the committee, Dr. G. W. Morey of the Geophysical Laboratory, Washington, recently sent a circular letter to the members of the Glass Division requesting them to enumerate the subjects which they deem desirable for investigation and to indicate their relative importance.

Before adopting a definite program it may prove profitable for all those interested in this movement for co-operative research to study the work that other countries are doing along similar lines. The best known effort in this field is that of the British Delagacy for Glass Research whose work, supported by donations from glass manufacturers and Government funds, is carried on at the university at Sheffield. The last annual report of this organization, now in its fifth year, shows a history of steady development. It has attempted, with varying degrees of success, the solution of a variety of problems. Its educational work is important, its laboratory and consulting work for manufacturers has assumed considerable proportions and its list of researches, either planned or already in progress, denotes an ambitious program of broad activities. This list†, reprinted here, may contain suggestions bearing on American glass problems.

I. *Chemical Researches*

A. *Fundamental Researches.*

*Determination of the specific effect of silica, boric oxide, lime, magnesia, zinc oxide, lead oxide, baryta, alumina, zirconia, soda, and potash on the durability of glass, and the effect of mixtures of these oxides.

B. *Specific Researches.*

*1. Investigation of a satisfactory autoclave test for the determination of durability.

*2. Investigation of satisfactory etching reagents.

*3. Determination of the best compositions of glass bottles and dishes for various purposes.

II. *Physical Researches*

A. *Fundamental Researches.*

*1. The study of the annealing conditions for glasses containing the oxides mentioned under I, A.

*2. The determination of the coefficient of expansion, refractive index, density, crushing strength, and elasticity of the glasses referred to in (1).

*3. Determination of the viscosity and working range of glasses containing specific constituents.

B. *Specific Researches.*

*1. Determination of the bursting pressures of bottles of definite composition and form.

*2. Correlation of the cracking temperatures of bottles and other forms of containers with form, relative thickness, and other factors.

*3. Design of simple apparatus for testing condition of annealing.

III. *Researches on Glass Production*

A. *Fundamental.*

*The effect of different proportions of cullet on the properties of glass.

B. *Specific Researches.*

*1. The production of a satisfactory lampworking glass.

*2. Preparation of opaque colored glasses for artificial human eyes—opal, red, blue, amber, black.

*3. Utilization of various waste products in glass manufacture.

*4. Production of homogeneous glasses of composition included under I, A.

†*Journal of the Society of Glass Technology*, Vol. 4, No. 15, pp. 294-296.
*Researches on these subjects have already made progress.

5. Experiments in the electric melting of glass.

6. Investigation of the production and properties of fused arsenic sulphide glass.

IV. *Researches on Glass Refractories*

A. *Fundamental Researches.*

*1. Systematic investigation of the composition and physical properties (drying, shrinkage, firing, contractions, porosity, density, and refractoriness) of different types of British fireclays, untreated and after treatment.

*2. Investigation of a satisfactory quantitative method of determining the corrosion of refractory materials.

3. The effect of specific batch ingredients in corroding fused refractory materials.

B. *Specific Researches.*

*The properties of refractory stone used for furnace blocks.

V. *Furnace Tests*

A. *Fundamental.*

The systematic study of existing commercial melting and annealing furnaces with a view to their improvement.

B. *Specific Researches.*

The permeability of glass pots to furnace gases.

VI. *Light and General Engineering Problems*

*1. The design of a machine for making T-pieces, taps, etc.

*2. Design of an improved burner for cracking-off operations.

3. A study of the effectiveness of different types of mixing machine with a view to an improvement in design.

Dr. Morey's call for suggestions requests that they be sent promptly to any member of the committee on co-operative research, which besides himself includes Dr. W. C. Taylor of the Corning Glass Works, Corning, N. Y., and Prof. H. S. Hower, Carnegie Institute of Technology, Pittsburgh, Pa.

Who Will Seize This Opportunity?

At the recent annual meeting of the American Ceramic Society, Prof. Alexander Silverman, the noted glass chemist, called attention to the backwardness of the United States in respect to educational facilities in glass technology. Among American glass manufacturers there are quite a number of shining financial lights, any one of whom could easily endow a school of glass technology at some suitable American institution, with great credit to himself and corresponding benefit to the trade out of which he made his money. All glass men will fervently hope that the right man will soon discover himself.

Should such a school become a reality, it is greatly to be desired that its facilities be made available to young men of limited means as well as those in more affluent circumstances. At the Sheffield School, to which Prof. Silverman referred, it is possible for the student to spend part of his time at the university and part in a glass works, thus combining theory and practice, and it is also possible for the student to earn sufficient funds during one part of the year to study during the other part.

Technical Consultation Service

THE GLASS INDUSTRY invites its readers to refer to this department any problems with which they may be confronted pertaining to raw materials, glass technology, laboratory and factory practice. While making no pretensions to the possession of unbounded knowledge or infallibility THE GLASS INDUSTRY is ready to assist its readers to the best of its ability in solving their problems. Readers who can offer better suggestions are invited to submit them.

Answers to all questions will be made by mail as promptly as possible. The source of all inquiries will be held in strict confidence.

QUESTION 4.—We are dealers in scientific apparatus and have received a consignment of volumetric flasks, which were apparently in perfect condition at the time of delivery. They were carefully standardized and stored in the basement of our supply house. After a few months they were found to be covered with large white spots and had become crystalline. Please advise us what, in your opinion, has caused this trouble and how it can be prevented.

ANSWER.—From your description we are inclined to think that the glass of the flasks contains too much alkali and not enough lime; in other words, that the batch from which it was made was not properly balanced. Boil a little distilled water in one of the flasks, allow to cool and add a piece of red litmus paper. If it turns blue, it will do so on account of excessive alkali which dissolves in water. The test will only be effective in extreme cases. The following test will prove whether or not glassware is resistant against the action of water and atmospheric influences. Place the glass object under a bell jar and put a small beaker containing hot concentrated hydrochloric acid near it. Expose the glass to the acid vapors for about 24 hours and then allow it to dry in a place which is free from dust. If on drying a fine white dust appears on the surface, the glass should be rejected as unfit for scientific uses. We can suggest no other remedy for this condition than the advice that you communicate with the manufacturer, who should give this matter his attention.—J. B. K.

QUESTION 5.—We have taken over the assets of a window glass company after destruction of the factory by fire, from which the tank has suffered no damage. It was found that the glass in the tank was white in color, and it has been found impossible to restore it to the liquid condition. We desire to know: (1) is it possible to melt this glass and restore its former qualities; (2) if not, can the material be used as cullet?

ANSWER.—This is an unusual case and we regret that we cannot give advice which is based on a similar experience. The glass in the tank has become thoroughly devitrified during the slow process of cooling after the fire. While it has practically the same chemical composition as clear glass, it seems doubtful if the average furnace can develop sufficient heat to melt a tank full of devitrified glass. In our opinion, it would be advisable to remove the glass from the tank. It should be crushed to pea size and mixed in small quantities with the batch and cullet. We feel sure that, if used in this way, no difficulty will be found in melting it.

J. B. K.

The Laboratory

By J. B. KRAK

Technology and Analysis of Salt Cake

Salt cake is formed through the action of sulphuric acid upon common salt. At the same time hydrochloric acid is formed. The reaction takes place in two stages; the temperature in the second stage must be considerably higher than in the first to complete the operation.

In the first stage sodium bisulphate is formed, which reacts with salt during the second stage. The reactions are as follows:

I. $NaCl + H_2SO_4 = HCl + NaHSO_4$
(salt; sulphuric acid; hydrochloric acid; sodium bisulphate)

II. $NaHSO_4 + NaCl = HCl + Na_2SO_4$
(sodium bisulphate; salt; hydrochloric acid; salt cake)

Another method of making salt cake is the Hargreaves process. Damp salt is pressed into blocks and dried. It is then charged into vertical, cast iron retorts, a number of which are connected in series. They are heated to about 500° Centigrade. Sulphur dioxide, steam and air are made to pass through all the retorts in succession. The hydrochloric acid is carried along with them. A cylinder containing 40 tons of material requires from 15 to 20 days' continuous action to secure complete conversion. As soon as sulphur dioxide ceases to be absorbed in a given cylinder, the latter is cut out from the series, the salt cake removed, a new charge of salt blocks introduced and the cylinder made the final one of the series, so that newly charged salt is exposed to the most nearly exhausted sulphur fumes. The following is the reaction:

$2\,NaCl + SO_2 + H_2O + O = Na_2SO_4 + 2\,HCl$
(salt; sulphur dioxide; steam; oxygen (from air); salt cake; hydrochloric acid)

The advantage of the Hargreaves process is the great purity of the product. The well-known mirror glass works of St. Gobain, near Paris, operate a Hargreaves salt cake plant to supply their own needs.

Pure salt cake is white. It has a faintly yellow color when hot. It should run from 95% to 97% in purity. The material may be contaminated with iron, common salt, free acid and gypsum, and it contains sometimes a small amount of magnesium sulphate. Salt cake should not contain over 0.5% salt, 1% free acid (SO_3) and 0.5% gypsum. For mirrors no more than 0.02% of iron is allowed. For window glass the limit may be as high as 0.3%, provided the other ingredients of the batch are very low in iron.

DETERMINATION OF IRON.—Dissolve 50 grams of salt cake in about 350 cubic centimeters of water, add 25 cubic centimeters of sulphuric acid (1:4) heat to boiling and reduce the iron with a strip of pure metallic aluminum. Titrate with N/20 potassium permanganate.

1 cc. N/20 $KMnO_4$ = .0056% Fe
1 cc. N/20 $KMnO_4$ = .0080% Fe_2O_3

DETERMINATION OF FREE ACID.—Dissolve 20 grams of salt cake and dilute to 250 cubic centimeters in a volumetric flask. Pipette 50 cubic centimeters, add methylorange and titrate with N/10 sodium hydroxide to a straw yellow color.

1 cc. N/10 NaOH = 0.1% SO_3
1 cc. N/10 NaOH = 0.1225% H_2SO_4

DETERMINATION OF SODIUM CHLORIDE.—Pipette another 50 cubic centimeters of the solution. Add the same number of cubic centimeters of N/10 sodium hydroxide, as were required to completely neutralize the free acid. Add a few drops of potassium chromate solution and titrate with N/10 silver nitrate. Deduct a blank of 0.2 cubic centimeters.

1 cc. N/10 $AgNO_3$ = 0.146% NaCl
1 cc. N/10 $AgNO_3$ = 0.177% Na_2SO_4 equivalent to NaCl

DETERMINATION OF GYPSUM.—Dissolve 4.856 grams in about 200 cubic centimeters of water, add 10 cubic centimeters of hydrochloric acid, a few drops of nitric acid and heat to boiling. Add ammonium chloride and ammonia, until alkaline to litmus, filter and reject the precipitate. To the filtrate add ammonium oxalate; filter, ignite and weigh as CaO.

Weight of CaO × 50 = % $CaSO_4$
" " CaO × 20.6 = % CaO

MAGNESIA, if present, may be estimated in the filtrate of the calcium oxalate precipitation, with microcosmic salt solution and weighing as magnesium pyrophosphate.

Weight of $Mg_2P_2O_7$ × 22.26 = % $MgSO_4$

DETERMINATION OF SODIUM SULPHATE.—Dissolve 1 gram of salt cake in hot water, add a few drops of sulphuric acid, then ammonium chloride, ammonia and ammonium oxalate. Filter and evaporate the filtrate to dryness in a platinum dish. Heat over an open flame until all fumes are driven off and weigh. Deduct the sodium sulphate equivalent of the amount of sodium chloride found previously, and also the percentage of magnesium sulphate, if present. The difference, multiplied by 100, gives the percentage of sodium sulphate in the salt cake.

INSOLUBLE RESIDUE.—Weigh 100 grams of salt cake and dissolve in about one liter of hot water, under constant stirring to prevent the formation of large cakes, which dissolve slowly. Allow to stand for several hours, preferably on a steam bath, until all soluble material has gone in solution. Filter, wash with hot water, ignite and weigh.

Weight of insoluble residue equals per cent.

MOISTURE is determined on a one-gram sample at 105° Centigrade.

Indelible Labels on Bottles

To affix indelible labels on bottles, an etching liquid is employed which is produced as follows:

LIQUID I. Dissolve 36 parts of sodium fluoride in 500 parts of water and add 7 parts of potassium sulphate.

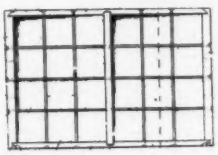
LIQUID II. Dissolve 14 parts of zinc chloride in 500 parts of water and add 65 parts of muriatic acid.

Keep both liquids in separate bottles. For use, mix equal parts together, preferably in a wax bottle, and add a little dissolved India ink to render the writing more visible.

Patents

RECENT INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Knockdown Bottle Case. U. S. 1,364,968. January 11, 1921. Andrew L. Wagstaff, of Kansas City, Missouri, assignor, by mesne assignments, of two-thirds to American Bottle Case Company.



This invention relates to cases for holding soda bottles. milk bottles, or in fact all kinds of bottles carried in cases, and one object is to provide a comparatively simple, inexpensive and compact device capable of standing the rough usage to which cases of this character are subjected.

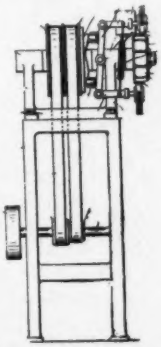
A further object is to provide a nailless box of light but substantial construction in which the different parts can be readily taken apart for shipment in knockdown form to effect a saving in space and freight charges. Another object is to provide a case embodying means whereby any looseness caused by shrinkage or otherwise can be readily taken up and thus prevent the case from collapsing from such cause.

Glass Casket. U. S. 1,365,633. January 11, 1921. Hiram Tyree, of New York, N. Y., assignor to International Glass Casket Company, of Wilmington, Delaware.

The invention provides a relatively light, strong and imperishable casket structure made of reinforced vitreous or similar fictile material, possessing various advantages not heretofore available in this art, as hereinafter disclosed. The principal objects of the invention are to produce an organization of the fictile material and its reinforcement in such form and arrangement as to enable the caskets to be efficiently manufactured in plunger molds and at a minimum of cost and to be closed by a soldered metallic seam or seal which permanently attaches the cover to the casket body either with or without the aid of cement, the use of which is also provided for, and also to improve the utility and appearance of glass caskets in general and to simplify and reduce the cost of finishing the same.

Lens-Polishing Machine. U. S. 1,366,159. January 18, 1921. Lucian W. Bugbee, of Indianapolis, Indiana, assignor to one-piece Bifocal Lens Company, of Indianapolis, Indiana.

The object of this invention is to improve, facilitate and cheapen the polishing of toric, meniscus and other lenses, so as to improve the polished surfaces of such lenses and reduce the cost of polishing the same.

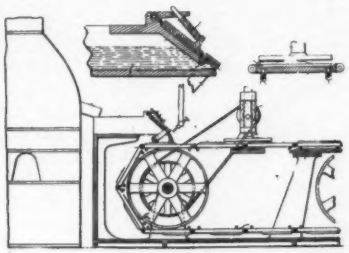


One feature of the invention consists in the combination of a spotting wheel with the spots cut in the metal surface thereof, whereby the lens blanks can be secured thereto with the edges mounted directly on and in engagement with the metal surface of the wheel. The blanks are secured thereto by pitch or other adhesive material between the middle portions of the blanks, and means for applying to the outer surface of the blanks, when so mounted on said spotting wheel, a plurality of polishers made of, or covered with pitch. This construction will polish the blanks rapidly and without the heat, generated by the friction of the polishers on the lens blanks, softening the pitch so as to interfere with the successful operation.

Means for applying a constant stream of rouge and water to the pitch polishers is also preferably provided, for insuring that the pitch of the polishers shall remain sufficiently hard to polish successfully.

Machine for Casting Plate-Glass. U. S. 1,363,450. December 28, 1920. Harry O. Bisbing, of Detroit, Michigan.

The invention relates to glass making, especially that of plate glass, and consists in mechanism for delivering glass to containers from the furnace in consecutive order and the final delivery thereof after the glass is cooled, whereby the casting of plate glass is substantially continuous.

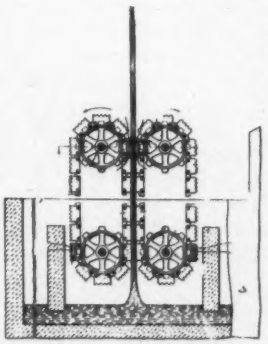


The combination includes a reservoir adapted to contain molten glass, a discharge passageway leading from said reservoir, a chain-like series of platens adapted to receive glass from such discharge passageway, means for bringing each platen in place to receive glass, a flap valve closing the discharge passageway opened by each platen successively as the same is brought into receiving position, means for closing said flap valve after such platen has passed from its receiving position, and a tamping plate adapted to be brought into contact with the glass carried in each platen leveling and smoothing the same.

Method of Gripping and Cutting Sheet Glass. U. S. 1,367,858. February 8, 1921. Hudson S. Campbell, of Clarksburg, West Virginia.

This invention relates to a method of gripping and cutting sheet glass.

In an application previously filed, the inventor set forth and claimed a method of drawing sheet glass in which the sheet of glass is drawn continuously from a molten bath of glass, the glass being severed and simultaneously therewith the succeeding sheet is gripped while it is still in its plastic soft condition. In that method the glass was severed by a knife edge on one of the gripping bars co-operating with the oppositely arranged gripping bar to sever or cut the sheet transversely during the drawing operation. The present invention relates to a method by which this cutting or severing of the sheet during the draw is accomplished by electrical means, provision being made for nicking the glass transversely of the sheet, and at the same time heating it along this line electrically so that it may be readily broken or cracked off along this line of heat.



The inventor claims that this method provides a very simple

and efficient method for severing the glass into sheets of any desired length, as it is apparent that by changing the position of the gripping bars, the cutting action can be made to take place at any desired point according to the size of the sheet desired.

Double Ring for Glass Factories. U. S. 1,367,027. February 1, 1921. Joseph Durieux, of New Eagle, Pennsylvania.

This invention relates to new and useful improvements in devices used in the drawing of glass and particularly to drawing rings.

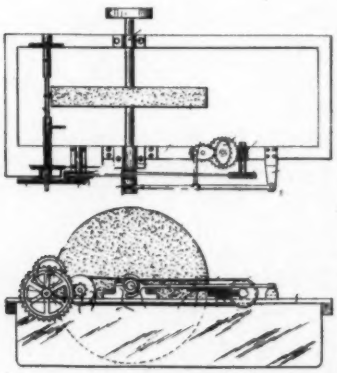
One object of the present invention resides in the provision of a novel and improved drawing ring which combines features whereby stones and other foreign substances will be automatically excluded from the innermost portion of the ring and whereby the drawing ring will be prevented from getting too near the edge of the tank.

The ring comprises an inner smaller wall and an outer larger wall, disposed in parallel spaced relation and of semi-elliptical outline. The inner wall is of slightly greater height so that when the ring is afloat in the molten glass in the tank, stones and other foreign substances will be excluded from within the inner wall. Connecting the ends of the two walls are the straight vertical walls. The ends of the outer wall are extended beyond the vertical wall, for engagement with the wall of the tank, to prevent the ring from getting too close to said tank wall, and interfering with the proper operation of the glass drawing.

Extending between the side portions of the walls and spacing said walls apart are the webs, while a web is disposed between the bight portion of said walls, and a web between the straight walls.

Lens-Edge Grinding Machine. U. S. 1,367,933, February 8, 1921. Louis Wilhelm, of New Haven, Connecticut.

This invention relates to an improvement in lens-edge grinding machines of the type which includes a grinding-wheel, a lens-holder adapted to present the edge of a lens to the edge of the grinding-wheel with means for moving the grinding-wheel back and forth so that its face will be uniformly employed. In the more general construction of machines for this purpose, the grinding-wheel is moved by means of an eccentric so that the movement is not at a uniform speed, but is faster at one time than at another, thus bringing more wear at one point than at another, owing to the position of the eccentric by which it is moved.



The object of this invention is to provide means for moving the grinding-wheel at uniform speed so that its entire grinding surface will be brought into use and the wear will be uniform throughout.

The usual grinding-wheel mounted upon a longtitudinally movable driving-shaft supported in bearings on a frame is employed. On the outer end of the shaft is a head co-acting with a yoke of a lever which is pivoted to a bracket mounted on the frame. This lever is connected by a link with an elliptical gear meshing with an elliptical gear connected with a worm-wheel engaging a worm provided with a belt-pulley.

The machine shown in the illustration also includes the usual lens chuck-shaft by which the lens is supported to present its edge to the grinding-wheel.

Glass-Molding. U. S. 1,368,958, February 15, 1921. Frederick W. Miller, of Hockley Heath, England.

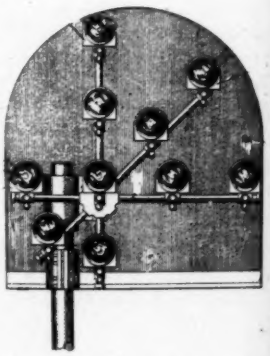
The object of the present invention is to provide an improved and simplified process of molding which does not require the use of highly skilled labor, and which results in the production of more sharply defined and better finished articles than are produced by existing processes.

According to the invention, the articles are molded by placing powdered or comminuted glass or enamel in a thin metal mold and fusing the same, and after the glass or enamel has been allowed to cool the mold is dissolved or removed therefrom by suitable means. In the production of an article in relief in two colors, such as a cameo, the recessed part of the mold is filled in with powdered glass or enamel of the desired color for the raised design, and the remainder of the mold is filled up with powdered glass or enamel of another color to form the background when the whole is fused together. By a similar process more than two colors may be obtained.

In carrying out the molding of a glass or enamel article in accordance with this invention a mold is used, consisting of a thin metal shell preferably made of sheet copper and produced by a stamping or pressing operation, or by electro-deposition. The bottom of the mold is recessed or sunken according to any desired design in order to form the raised or embossed portion of the article.

When the molded glass or enamel is quite cold the mold is dissolved by placing it in an acid bath for a short time, leaving the article with the design perfectly sharp and well-defined. Instead of removing the mold by placing it in an acid bath, it may be dissolved away by electrolysis, being used as an anode.

Optical System for Projectors. U. S. 1,363,566. December 28, 1920. William Churchill, of Corning, New York, assignor to Corning Glass Works, of Corning, New York.



This invention has for its object to provide an improved optical system and means of illumination which, while capable of use in projectors generally, is especially applicable for use in the projecting elements of the so-called "position-light signals."

Lens. U. S. 1,363,805. December 28, 1920. Abraham L. Morrison, of Dubuque, Iowa.

This invention relates to a glass for a headlight of an automobile. The lens comprises a glass having one half or a portion thereof frosted or chipped and ribs provided on the other half.

Said ribs have an inner short angular wall or face and an outer long angular surface, and the central ribs have slightly diverging walls to emit a direct light therethrough.

The light is diffused through the frosted part in a glow and the direct beams are broken up by the ribbed portion and are projected therethrough, which uniting with the diffused glow from the frosted part provide a soft light and at the same time a light that penetrates the darkness far in advance of the car.

Lens. U. S. 1,364,960. January 11, 1921. Harry B. Styll, of Southbridge, Mass.

This invention relates to improvements in ophthalmic lenses formed from two or more pieces of material.

Glass Factory Equipment and Supplies

THE GLASS INDUSTRY will be glad to publish descriptions of new and useful devices, machinery and supplies of interest to the glass manufacturing trade. Most of the information printed in this department comes direct from the manufacturers of the products described.

Twyman's Apparatus for Determining the Annealing Temperature of Glass

This apparatus is the outcome of a series of researches that were carried out in 1915 and the beginning of 1916, the object of which was to determine the scientific principles underlying the phenomenon of defective annealing of glass, and the factors governing the annealing process. The experiments had in view the annealing of optical glass, and of domestic and chemical glassware. In so far as glassware is concerned, the results have been summarized in a lecture before the Society of Glass Technology.* Except that a higher degree of annealing is necessary in the case of optical glass, there is no essential difference in the principles involved.

In the above lecture the author points out that the rate at which annealing takes place at any temperature is determined by the viscosity, and that a knowledge of the viscosity of glass at any temperature immediately enables one to calculate in what time any desired perfection of annealing can be attained at that temperature. The factors involved are three in number:—

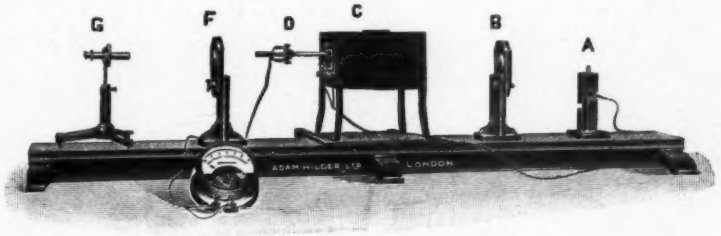
(*a*) The perfection of annealing that is to be attained.

(*b*) †The length of time in which it is desired that this degree of annealing should be effected.

(*c*) The variation of viscosity of the glass with temperature.

Both calculation and experience show that *a* and *b* can be so defined as to give perfect annealing in a very short time without risk of undue softening of the glass. All then that is necessary in the case of each kind of glass dealt with is to know precisely the temperature at which the viscosity of the glass has a known value, a value, that is, which is completely defined for any glass by conditions (a) and (b) above. The apparatus described below has been designed to enable this temperature to be arrived at with great accuracy, with a minimum of skill, and with a delay of only a few hours.

A further result of the researches in question shows that for all the glasses tested (which were a considerable number) the variation of viscosity with temperature followed the same or very nearly the same law. This discovery greatly simplified the operation of finding the annealing temperature in a particular case, since it is only necessary to make an observation at one temperature.



EQUIPMENT COMPRISING THE TWYMAN APPARATUS

The apparatus is shown in the figure and consists of an electric furnace (C), a pyrometer (D) and temperature indicator (E), an optical system—lamp (A), lens (B), lens (F), telescope (G), a jig for holding the strip of glass under observation.

The electric furnace is of a tube pattern wound with nichrome wire, and is fitted with mica windows. A switchboard and regulating resistance are supplied. The pyrometer and indicator consists of a Pt. Pt-Ir thermocouple and millivoltmeter reading direct in degrees centigrade. The optical system is substantially mounted on an oak base, and consists of a small metal filament lamp which can be run from a 4-volt accumulator, an achromatic condensing lens, an achromatic object glass, and a reading telescope with a divided circle. The jig is of nickel or of nichrome, and is so constructed that one end of a small strip of the glass may be slipped into the base, while to the other end is fixed a weighted arm. A nickel or nichrome straight-edge is provided, the inclination of which measures the bending of the strip.

The method of experiment is extremely simple, and is as follows:

A strip of glass of dimensions specified in the instructions sent out with the apparatus is inserted in the nickel jig, and placed in the middle of the furnace. The telescope (G) is then focussed upon this jig, and the cross-wire in the focal plane of the telescope set so as to be parallel with a straight edge, which forms a part of the jig, and is supported by the strip of glass. The temperature of the furnace is then raised until the strip of glass begins slowly to bend, and the rate of bending is then measured over a period of, say, ten minutes, by following the tilt of the straight edge above referred to by means of the cross-wire in the telescope (G). During this, the temperature of the furnace is kept constant and recorded.

A simple calculation then immediately gives the annealing temperature of the glass.

*(F. Twyman, on the "Annealing of Glass," Transactions Society Glass Technology, 1917, Vol. I.)

†A note in amplification of condition (b) above is necessary. Obviously in any kind of annealing under manufacturing conditions it is desired that the annealing should be done in the shortest possible time. Theoretically, a temperature can be found at which the annealing will be effected in any stated time, no matter how short, once the entire object to be annealed has been raised so as to be of that temperature throughout. But obviously the length of time necessary to heat to that temperature without fracture, or to cool down again from that temperature in such a way as not to reintroduce want of annealing, is an important, and in most cases a preponderant factor in the total time of annealing. Furthermore, if it be stipulated that the time of annealing should be very short a temperature may be arrived at at which the object is so mobile as to be deformed during the course of annealing by its own weight. It is this point which forms the greatest stumbling block to practical men in their consideration of the principles of annealing as established by Twyman, and it is not surprising that they sometimes express irritation when the annealing temperature is defined (see the lecture cited) as the temperature at which annealing will take place in three minutes, when actually the principles adopted lead in practice to an annealing process which occupies some hours. Those desiring further elucidation of this subject are referred to the lecture in question, and are invited to communicate with the makers of the apparatus described above.

A detailed and fully worked out example of the routine for the determination of the annealing temperature with full specification of size of glass strip, etc., is furnished by the makers of the apparatus. The importance of knowing accurately the annealing temperature for a glass seems to be very little realized as yet. Twyman's experiments have shown, however, that if, at a temperature of 500° C. satisfactory annealing of a particular glass will occur in one hour, then at a temperature of 420°C., it would take 1,000 hours for the same degree of annealing to be attained. Such is the disadvantage of not heating to a sufficiently high temperature.

If, on the other hand, the temperature is taken unnecessarily high, there are great drawbacks. First, the glass may get too soft, so that the articles go out of shape. Secondly, there is a loss of time consequent on raising the temperature unnecessarily high and allowing it to fall again to the lower temperature which would suffice.

To these must be added a third great drawback. It is very necessary not only to anneal the glass, but to see that faulty annealing is not reintroduced as the temperature is lowered. If the temperature is raised only just sufficiently high for annealing to take place, the temperature will naturally fall slowly through the range within which faulty annealing may occur. When the temperature has got below that range, it is impossible to reintroduce want of annealing by means of cooling, however rapid; the cooling may even be so fast that the articles are fractured, without any permanent strain being introduced. If, however, the temperature is taken unnecessarily high, it will naturally be falling rapidly throughout the very range where slow cooling is essential.

Furthermore, it must be realized that even with great care in control of the ingredients of glasses—even, for instance, in the manufacture of optical glass—it is not possible precisely to repeat meltings so that the annealing temperature of successive melts will be the same; while in cases where the care taken is not so great, variations of as much as 60°C. may occasionally occur.

Applying Twyman's law, one finds that if a mistake in annealing temperature of as much as 56° is made, the furnace, that is, being 56°C. below the correct annealing temperature, it will take no less than 2^7, namely 128 times as long to produce the desired degree of annealing as would be the case if the furnace had been at the correct temperature.

It is interesting to note that recent experiments of A. Q. Tool and J. Valasek‡ verify the correctness of these results and method.

It may be added that the apparatus has been installed in glass works of very varied character, including those manufacturing optical glass, chemical glassware, domestic glassware, bottles, and high tension electric insulators.

It is often objected by practical men that owing to the great difficulty of maintaining a lehr at any desired temperature precise methods of arriving at a knowledge of the best temperature to use are unnecessary. It is strange that practical men should arrive at so unpractical a conclusion. It is evident that if, for instance, a rifle gives to the bullet fired by it certain indecision of direction, the precision of the marksman who aims it must necessarily be all the greater if he is to secure a particular number of hits.

In the same way, if it is essential that the temperature of the objects under annealing be kept within a range of, say, 40°, and if the uncertainty of temperature within the lehr amounts to 30°, then the method of determining the annealing temperature must be precise to plus or minus 5° or the correct annealing may not take place.

With Twyman's apparatus there is no reason why the annealing temperature of the glass in the furnace should not be determined daily, and if the annealing temperature is found to vary from day to day similar variations should be made in the temperature of the lehr.

These considerations show how important it is that the annealing temperature of every glass used by a manufacturer should be accurately known to him.

Numerous polarization devices have been described in the past few years having for their object the examination of glassware for faulty annealing. Most of the apparatus has been constructed by scientific men in technical control at glass works, and no doubt meets in a satisfactory way their individual requirements.

The Strain-viewer made by Adam Hilger, Ltd., 75a Camden Road, London, N. W. 1, England, representing as it does the final form after a large number of experimental apparatus had been constructed, enables every kind of glass or glassware to be examined with the greatest possible speed and certainty by unskilled observers.

The strain due to faulty annealing is in this apparatus indicated not by the ordinary polarization effect obtained by crossed Nicols, but by an unmistakable coloration of the strain portions of the object under examination. These colors are present in a vivid manner even in very slightly strained articles.

Adam Hilger, Ltd., also make special apparatus for examination of objects made from dark glasses, such as dark colored bottles; although it is of course possible to apply the method to examine glass which is entirely opaque.

They also state that they will be glad to report on any glass article sent to them, and inform the sender whether it is suitable or not for examination by apparatus of this kind.

In the United States the Twyman apparatus is sold by Arthur H. Thomas & Company, Philadelphia.

Products of Chance Brothers & Co., Ltd.

In connection with the publication in our December issue of a communication from Chance Brothers & Co., Limited, Smethwick, Birmingham, an erroneous impression was given that the company manufactures bottles. During an active existence of more than a century they have never engaged in bottle manufacturing, their principal product being window glass.

An unusually well-gotten up catalog recently received from W. L. Foster, Director of the Company, illustrates their enormous works at Smethwick, Birmingham, and lists and describes the various standard and special products made there. Included in the catalog are the following varieties: window glass, rolled sheet glass (a product used extensively since the outbreak of the war as a substitute for ordinary sheet glass and particularly satisfactory for glazing horticultural structures, factories, hospitals, etc.), figured rolled glass, Flemish glass, muffled glass, rough rolled plate and rough cast plate, colored glass, MAXimum (prism) daylight glass, Old English crown glass, genuine crown glass bullions, microscopical thin glass, glass roof tiles and slates, heat-resisting glass and complete optical, lighting and mechanical apparatus for lighthouses, including all work in connection with such structures except masonry.

Soda Ash Made in Canada

Production of soda ash at Amherstburg, Canada, by the Brunner-Mond Company, Canada, Ltd., began in the fall of 1919, and the company has already found it necessary to enlarge its equipment. The Canadian concern was organized by interests connected with the Brunner-Mond Company of England and the Solvay Process Company, Syracuse, N. Y. The Solvay process is used for manufacturing the soda ash. Amherstburg is situated near Detroit, Mich., and unlimited supplies of salt and limestone are available nearby. Sir Edmund Walker is president of the Canadian company; E. N. Trump, vice-president and consulting engineer; A. H. Green, vice-president and managing director; Wells Camp, vice-president and secretary; and G. N. Conley, manager of the plant.

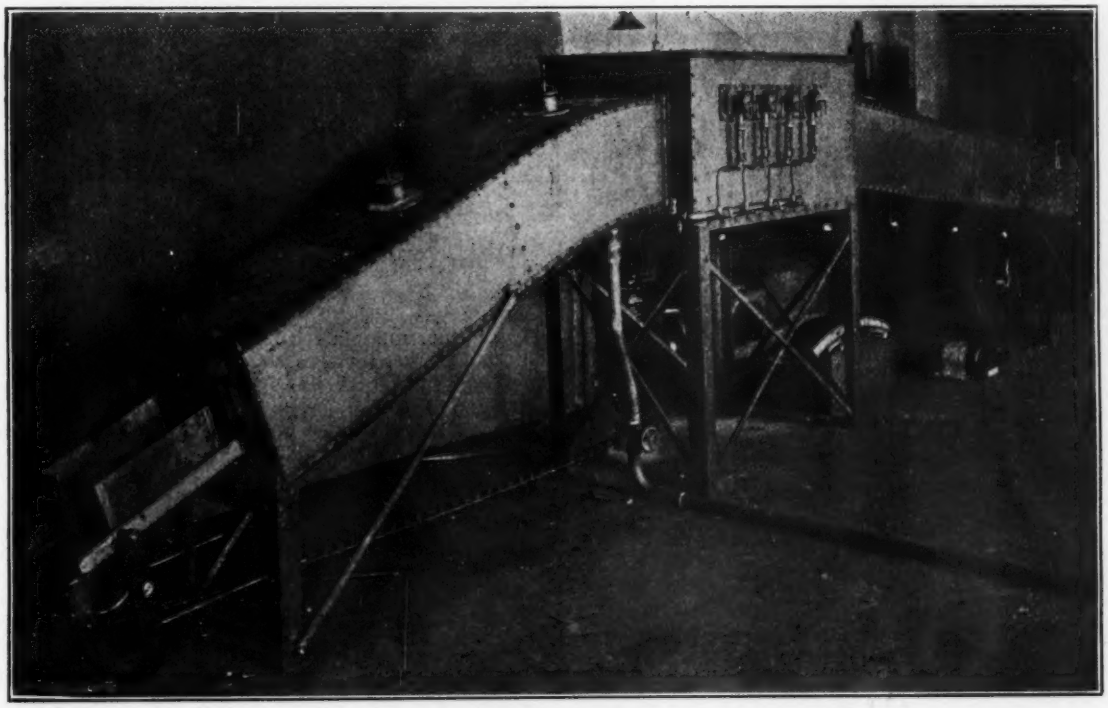
‡Scientific Papers of the Bureau of Standards, No. 358, "Concerning the Annealing and Characteristics of Glass."

A New Re-Annealing Furnace*

A new type of re-annealing furnace developed by George Keith of Keith, Blackman & Company, Ltd., London, England, was described in a paper presented before the Society of Glass Technology of Great Britain at its December meeting by Dr. W. A. Whatmough, who collaborated with Dr. Keith in the experiments that led to the development of the new furnace. The essayist emphasized that "the object of this paper was to put before the members of the society the results of three years' experience in the re-annealing, on a commercial scale, of small glass articles in a coal gas-fired lehr of peculiar construction. In the early stages of his paper, the essayist emphasized the difference between the annealing or slow cooling of glass, which, he said, was ordinarily resorted to in the glasshouse, more with the idea of preventing the development of strain through rapid cooling than for the purpose of releasing stresses already present, and re-annealing, which involved the re-heating of glass to its softening point, thereby calling for an exactitude of temperature, and a regulation of the rate of heating and cooling not attainable in ordinary lehr practice. He strove to show that a method of re-annealing had now been evolved in which temperature curve, time of exposure, and cooling rate were each definitely controlled, which was equal to saying that commercial annealing had now assumed a new phase and become a definite process. Accordingly, throughout the paper the term "annealing" must be taken to mean that the article annealed was completely free from strain.

It should be borne in mind, said the essayist, that strain in glass was not an inevitable cause of fracture; indeed, the article might be all the stronger in consequence of strain. The real trouble was that strained glass was capricious in regard to fracture, especially when stressed unevenly. Change in the state of the strain increased the tendency to fracture. Local strains might become so intense that breakage must necessarily ensue. The particular type of the glass had also an important effect upon strain. Boro-silicate glass, which was difficult to handle, nevertheless withstood temperature changes very well, owing to low coefficient of expansion. Lead glass, on the contrary, annealed easily, which was one of the reasons for its popularity in lamp works. Strained glass was undoubtedly the greatest cause of loss in the manufacture of glassware, and cases in which it was advantageous not to anneal were rare.

After citing a number of interesting technical points which had a direct reference to the necessity of glassware being thoroughly re-annealed, the essayist showed by means of lantern slides an experimental re-annealing lehr jointly designed by Mr. George Keith and himself, and protected by patent. This took the form of an inverted syphon, having the entrance situated at a lower level than the exit. The tray track consisted of two shaped lengths of angle iron 25 feet long, joined by means of iron strips set down to carry the central train track, the top and sides of the tunnel being formed of sheet iron fastened to angle iron tracks. Two single brick walls were shaped to the track, and were covered with fireclay slabs which constituted the stand and the bottom of the tunnel, as well as the return tunnel for the conveyor chain. The lehr tunnel was completed by walls of brick, and a fireclay slab top with a lagging of slag wool between the sheet metal of the tunnel and the brickwork. The fire-box consisted of inner and outer walls of fireclay, the outer portion being built of firebrick and the top with stout firebrick slabs, which were bored to take the nozzles of four high-pressure gas burners on the Bunsen injector principle. Each burner made a self-burning mixture of coal gas and air, and was capable of consuming 60 cubic feet of coal gas per hour. Chain wheels and reducing gear were arranged so as to allow the lehr to be cleared in half an hour, one hour, or two hours, as might be desired. The actual lehr itself was 22 feet long, 7 inches wide and 5½ inches high. The short leg at entrance to tunnel was 4 feet long, and the longer limb at exit 12 feet long. The fire-box portion was 3 feet 6 inches.



A NEW TYPE OF RE-ANNEALING FURNACE.

The essayist claimed that the feeding of hot combustible products under pressure to a lehr tunnel on the inverted syphon prin-

*Abstract from the *Pottery Gazette*, London.

ciple, with a lowered limb to entrap the gases at the entrance, resulted in a steady flow of heat along the longer leg of the syphon at the outward end. The entrance was screened so as to avoid bodily transference of lehr atmosphere, and the re-heated trays of articles could be relied upon to convey heat from the firebricks along the long leg. The heat gradient was governed by the gradual loss of radiation, which was controllable by suitable lagging, and the temperature could be reduced at any desired point by letting off a portion of the hot gases. If brickwork only were used as insulation, the radiation losses at high temperature were very high, and this had a vital bearing both on annealing and gas consumption.

In the original experimental lehr, as described, it was soon evident that much heat was lost through the outer wall of the firebricks, and also through the brickwork at the hot end of the cooling leg. Accordingly, the fire-box was subsequently lagged with several inches of slag wool, and 3 feet 6 inches of brickwork next to the firebricks was removed and substituted by slag wool, the new lagging being held in place by sheet metal. By this alteration the effective annealing length of the lehr was increased by about 33 per cent, solely on account of the conservation of heat.

As the result of two years' experience a lehr with a tunnel 9 inches square was designed. In this all the lagging consisted of slag wool enclosed between metal plates. All the difficulties that were encountered in the experimental lehr were successfully overcome, and the result was that a practical working lehr had been designed which had now been in actual work for some months, and was being utilized very successfully for the annealing of the glass portions of electric light meters, which, as would be well known, involved several delicate internal joints. The unannealed articles showed intense local strains, with the result that in different stages of working there was a production loss prior to the re-annealing amounting to more than 50 per cent. In order to cut this loss, re-annealing was now being resorted to in various stages of manufacture, the final re-annealing being done with the end of the article closed. The new system had had the effect of entirely cutting out the loss by breakage in the making, and the manufacturers stated that no breakage now occurred in the reworking. No doubt this was the result of the combination of perfectly annealed glass and the low coefficient of expansion.

The new lehr was capable of taking many times the days' production of meter tubes, so that each day's work, both partly and wholly completed, was put through in a morning of four hours. The remarkable success of the invention appeared to be due to the fact that it happened to put into practice the conditions laid down by the researches which had taken place at Sheffield. Fractional annealing was impossible, since an article that was passed through the lehr twice was annealed perfectly at a temperature 20 to 30 degrees below that which was necessary for annealing in a single transit. One of the main points to consider in dealing with the annealing problem, in the opinion of the author, was that satisfactory annealing meant something more than slow cooling, and any lehr, no matter whether the articles were fed into it in a hot or cold condition, should have a temperature zone high enough to remove any existing strains, without which real annealing could never be effected.

Trade News

All Items Verified Unless Otherwise Indicated

THE OHIO PLATE & WINDOW GLASS COMPANY, Toledo, O., has increased its capital stock from $35,000 to $200,000.

WHITALL-TATUM COMPANY, New York and Millvale, N. J., has elected John M. Whitall to the presidency of the company, and W. H. B. Whitall to be treasurer.

THE INDIANA GLASS COMPANY, Dunkirk, Ind., at a meeting of stockholders, elected F. W. Merry to be president; C. W. Smalley, vice-president; C. L. Gaunt, secretary and treasurer; H. J. Batsch, general manager.

The bursting of a tank filled with molten glass on March 3 started a fire which totally destroyed the KEARNS-GORSUCH GLASS COMPANY's plant at Barnesville, O., with an estimated loss of $300,000, substantially covered by insurance.

C. H. Harding, president and general manager of the HARDING GLASS COMPANY, Fort Smith, Ark., advises that the erection of their plant No. 2 is now entirely completed and operations will begin as soon as business conditions improve and definite wage conditions determined.

JOHN N. ILLIG, Corning, N. Y., has purchased property situated at Denison Parkway and Erie Railroad and will erect an up-to-date plant for the manufacture of cut, engraved, rock-crystal and sculptured glassware. Mr. Illig reports that he will be in the market for supplies and equipment.

WILLIAM J. MILLER, Swissvale, Pa., announces that Alex McNish, an experienced mechanic, has arranged to sail for Europe, where he will install special Miller machinery in factories in England and France. It is expected that Mr. McNish will be gone about six months and while abroad will co-operate with Mr. Miller's British representative, W. F. Cargo.

THE CENTRAL GLASS WORKS, Wheeling, W. Va., through J. C. Fee, general manager, reports that they have planned quite a few improvements for their plant for the near future. The gas producer which is being installed will not be ready for operation for several weeks. Mr. Fee also states that the oil installation, costing $10,000, is now complete and is giving satisfaction. The entire interior of the plant is being painted in white, and wooden floors are being replaced by concrete.

Announcement was recently made of the merger of the George S. Good Fire Brick Company, and the Clearfield Clay Working Company, into the CRESCENT REFRACTORIES COMPANY of Curwensville, Pa. The output of the plants now operated by the corporation reaches 240,000 bricks per day. James B. Graham, president of the Northern Central Trust Company of Williamsport, Pa., has been elected president of the Board of Managers of the Crescent Refractories Company.

THE METAL & THERMIT CORPORATION, 120 Broadway, New York, widely known for its chemical and metallurgical specialties, is making arrangements to manufacture a line of ceramic oxides. The company had previously developed special processes for manufacturing tin oxides and will greatly extend its ceramic department under the supervision of Homer F. Staley, whose work in ceramics at the Bureau of Standards, with which he was until recently connected, is well known. For a considerable period Mr. Staley was editor of the *Journal of the American Ceramic Society*, but resigned upon taking up private work.

THE AMSLER-MORTON COMPANY, Pittsburgh, Pa., advise us that a great deal of interest is being shown throughout the trade in the

operation of the muffle lehr which they installed at the Advance Glass Company's plant, this lehr being designed on unusual principles. They also state that they are installing a special lehr conveyor for the Owens Bottle Company, Charleston, W. Va., and that they have practically completed new lehrs for the Eagle Manufacturing Company, Coshocton Glass Company (four 10-foot lehrs), Indiana Glass Company (two 10-foot lehrs), Hocking Glass Company (one 10-foot lehr). They also have installed a new gas producer plant for the Lancaster Glass Company, Chapman agitators for the Eagle Manufacturing Company, and are working on a 30-ton tank, 2 Chapman producers and one radial tile chimney for the Jeanette Glass Company.

Canadian Window Glass Plant

THE MCCAMIC-BATCHELL-BERGMAN COMPANY, glasshouse engineers and contractors, Toledo, O., who constructed the six window glass tanks for continuous window and sheet glass production by the Colburn process at the Libbey-Owens Sheet Glass Company's plant at Charleston, W. Va., have contracted to build for the Canadian Libbey-Owens Sheet Glass Company two similar tanks at their new plant at Hamilton, Ontario, Canada. It is stated by Wm. S. Bergman that work will be started the latter part of March.

Oregon Opportunities

In an address delivered to the students of Reed College, Portland, Ore., Fletcher Lunn declared that "Oregon has the silicate, the soda ash and other products necessary to build a large glass manufacturing industry, besides a wealth of other raw materials which can be used in making this state an industrial center."

Foreign Trade Opportunities

Recent issues of the Daily Consular and Trade Reports issued by the Bureau of Foreign and Domestic Commerce, Washington, D. C., list the following items. Further information concerning any of them may be obtained from the Bureau or its district offices by duly registered firms and individuals, by written request giving opportunity number.

Registration in the Importers' Index entitles the registered firm to receive further information concerning items listed in the Daily Commerce Reports. Registration may be obtained by making application to the Bureau of Foreign and Domestic Commerce, Washington, D. C., or to one of the district or cooperative offices located in nearly all of the large cities, and by filling out "form 57." Registered firms receive additional circulars and bulletins of various sorts relating to their particular line of business.

34406—A mercantile company in England desires to purchase in wholesale quantities white flint glass tomato-catsup bottles, of diamond shape, with screw neck for a metal screw cap. Quotations should be given c. i. f. London. Terms: Cash against documents. Reference.

34422—A firm of engineers in England desires to purchase or secure an agency for articles used in electrical and mechanical engineering, such as glass and metal reflectors or shades, etc. Quotations should be given c. i. f., London. Reference.

34435—A commercial representative in Cuba desires to secure exclusive agencies for the sale in Latin American countries, among other products, of glassware, etc. Quotations should be given f. o. b., New York or Southern port. Correspondence and advertising matter should be in Spanish. Reference.

34444—A commercial organization in Mexico desires to purchase bar glassware and requests illustrated catalogs. Quotations should be given c. i. f., El Paso, Texas. Cash to be paid. References.

34467—The director of a trade advising organization in India desires to secure agencies for machinery for manufacturing on a commercial and economical scale, glassware, glass bangles, window glass and glass bottles. Complete estimates are requested as regards prices, cost of production, number of men required to operate machinery, space required, cost of raw materials and finished products, and all information necessary. It is also desired that manufacturers send operators to India to erect factories and to instruct the natives in the use of the machines. No reference offered.

34472—A commercial agent in Syria desires to secure the representation of firms for the sale of glass and glassware. Quotations should be given c. i. f. Beirut or Alexandretta. Terms: Twenty-five per cent in advance and balance against documents. Reference.

34475—The commercial representative of the drug and hospital trade in Mexico desires to secure an agency from manufacturers for the sale of drug sundries, such as glassware, etc. Reference.

34493—A mercantile firm in Bulgaria desires to purchase and secure an agency for the sale of glassware. Quotations should be given c. i. f. Bourgas, Bulgaria. Correspondence should be in French. References.

Inquiries Received

Further particulars may be obtained from THE GLASS INDUSTRY.

No. 7—Kindly refer us to concerns which could furnish blown reflector bulbs of special design for use on electric signs. We have the necessary molds for hand blowing but no machine molds. Will need probably 5,000 bulbs to begin with and very large quantities later.

No. 8—Who makes "Quickseal" brand fruit jars?

No. 9—Where can we obtain a machine for trimming off the edges of tumblers?

No. 10—We are interested in selecting a line of bottles and glass jars for a manufacturer who is going to put out a new line of toilet goods, and are conducting a thorough investigation to ascertain what bottles and jars would appeal most to the public, from an artistic and practical standpoint. In case you have illustrated literature or data regarding the different lines on the market at present, we would appreciate receiving such as you can spare. We are particularly anxious to obtain illustrated literature on the following bottles.

Opaque bottles in an imitation Tiffany glass.

Opaque reddish brown imitation pottery, velvet finish.

A soft finished jet black bottle.

No. 11—Will erect plant for making cut, engraved, rock-crystal and sculptured glassware. Will need supplies.

National Association of Cost Accountants

The annual convention of the National Association of Cost Accountants will be held at Cleveland, O., September 14, 15 and 16, 1921. It is expected that this will be the largest gathering of cost men ever held in the United States. The Association recently announced a Thesis Competition open to its members who are invited to submit papers on subjects dealing with some definite phase of cost work. Cost men in the glass trade may obtain full particulars from the secretary at 233 Broadway, New York. The January issue of the Association's official publication contained a paper by Homer N. Sweet giving practical suggestions on purchase orders and records.

New Publications

CRAIN'S MARKET DATA BOOK AND DIRECTORY OF CLASS, TRADE AND TECHNICAL PAPERS, now on the press, promises to be of unusual interest to advertisers generally and users of trade and technical papers in particular. It not only lists all of the business publications of the United States and Canada, giving circulations, rates, type page sizes, closing dates, etc., but supplies a market analysis of each trade, profession and industry. Thus the reader is given the basic facts of each line in which he may be interested, including its buying power, buying methods, character of requirements, etc. The volume, which is bound in cloth and contains nearly 500 pages, is published by G. D. Crain, Jr., 417 South Dearborn street, Chicago, Ill. The price is $5.

MONTHLY SUMMARY OF FOREIGN COMMERCE OF THE UNITED STATES.
Corrected to January 29, 1921.

IMPORTS OF GLASS AND GLASSWARE.

Articles	December 1919 Quantity	December 1919 Value	December 1920 Quantity	December 1920 Value	Nine months ending December 1918 Quantity	1918 Value	1919 Quantity	1919 Value	1920 Quantity	1920 Value
Glass and glassware:										
Bottles, vials, demijohns, carboys, and jars, plain, ordinarily used as containers, empty or filled ....lbs. dut.	430,570	$15,805	646,786	$25,787	.....	$114,438	2,268,039	$115,928	7,079,432	$304,961
Bottles, decanters, and other glassware, cut or ornamented ....dut.	.....	48,821	.....	127,145	.....	223,367	.....	441,233	.....	1,208,394
Optical instruments, including lenses and spectacles ....dut.	.....	49,407	.....	79,449	.....	150,446	.....	340,023	.....	922,650
Sheet and plate glass—										
Cylinder, crown, and common window glass, unpolished ....lbs. dut.	114,368	12,163	1,174,024	105,698	433,776	54,072	1,033,902	137,901	6,228,384	623,919
Plate glass, cast, polished, unsilvered, sq. ft. dut.	.....	.....	355,349	313,252	273	210	4,173	3,055	2,569,565	2,271,288
Plates or disks, rough-cut or unwrought, for optical purposes ....lbs. free	7,756	26,217	105,308	86,159	.....	341,724	562,983	410,775	941,860	980,289
All other ....dut.	.....	37,744	.....	181,393	.....	467,265	.....	612,663	.....	2,188,625
Total	.....	$210,157	.....	$918,883	.....	1,351,522	.....	2,061,580	.....	8,500,126

EXPORTS OF GLASS AND GLASSWARE.

Glass and glassware:										
Bottles, demijohns, carboys, and jars	.....	534,158	.....	$11,860	.....	2,781,076	.....	5,283,655	.....	9,575,543
Chemical glassware	.....	16,066	.....	38,557	.....	179,682	.....	200,969	.....	262,391
Common window glass, boxes (50 sq. ft.).	67,201	$411,826	30,952	$242,412	683,215	$3,812,653	965,970	$6,492,608	593,808	$4,097,133
Exported to—										
France	3	$20	.....	.....	.....	.....	208,902	1,670,920	94	698
Canada	37,601	193,072	5,247	45,231	366,255	1,739,661	244,487	1,329,534	274,126	1,738,011
Mexico	2,746	24,475	3,917	33,101	17,201	112,735	23,365	176,770	32,331	267,482
Cuba	1,649	12,373	8,646	59,875	37,225	220,689	19,925	142,740	47,384	347,405
Argentina	2,649	27,359	365	3,234	52,118	377,644	89,310	634,850	32,867	227,008
Brazil	1,464	10,241	943	6,041	20,438	124,966	70,123	468,289	36,561	261,696
Chile	4,029	26,540	2,234	14,230	58,436	390,054	36,847	245,049	18,051	111,910
Uruguay	.....	.....	460	2,427	.....	.....	.....	.....	13,223	88,037
China	.....	.....	130	822	.....	.....	.....	.....	25,741	174,532
Japan	1,151	8,586	1,402	19,656	5,504	45,005	12,509	127,770	23,520	198,465
Australia	2,391	16,781	1,540	8,938	53,582	323,959	103,124	625,930	12,834	95,238
New Zealand	18	138	41	487	6,095	35,094	25,603	144,106	3,723	29,476
Other countries	13,500	92,241	6,027	48,370	66,361	442,846	131,775	926,650	73,353	557,160
Cut or engraved glassware	.....	$31,994	.....	$41,585	.....	$139,449	.....	$269,125	.....	$422,864
Plate glass, unsilvered .....sq. ft.	303,101	163,443	262,063	215,626	6,022,083	3,155,627	7,318,099	4,221,360	4,140,895	2,853,606
All other	.....	759,335	.....	1,701,500	.....	5,401,395	.....	8,328,944	.....	12,874,614
Total glass, etc.	.....	1,916,822	.....	3,051,540	.....	$15,469,882	.....	$24,796,661	.....	$30,086,211

Current Prices of Glass-Making Materials

From quotations furnished by various manufacturers and dealers New York, March 8, 1921

	Carlots.	Less Carlots.
Alumina hydrate .....lb.		.12 – .14
Arsenic trioxide (dense white, 99 per cent.....lb.	.09¼	.09¾
Barium carbonate.....ton	$65.00	$75.00
Bone ash .....lb.	.06¼	.06¾
Borax .....lb.	.06¾– .07½	.07 – .07½
Borax, fused, any mesh....lb.	.19	.20
Boric acid, fused.....lb.	.35	.35
Cadmium sulphide, red or orange .....lb.		1.60
Cadmium sulphide, yellow..lb.		1.80
Cobalt oxide.....bbls., lb.		3.00
Cobalt oxide,..... tins, lb.		3.10 –3.25
Copper oxide, red.....lb.		.17 – .20
Copper oxide, black.....lb.		.23 – .26
Feldspar, 100 mesh.....ton	18.00	
Fluorspar, powdered white 90 per cent.....ton	55.00	60.00
Kaolin .....ton	25.00	35.00
Kryolite .....lb.		.15
Lead oxide, (red lead, Fb_3O_4) .....lb.	.09¼	.09¼
Litharge (PbO) .....lb.	.08¾	.08¾
Lime—		
Hydrated .....ton	45.00	
Burnt .....ton	17.00	
Manganese (85% MnO_2)...lb.	.04¼– .06	.04½– .06½
Nickelic oxide (NiO) black—lb.		.35
Nickelous oxide (Ni_2O), green .....lb.		.38
Potassium Carbonate—		
Calcined .....lb.		.09 – .09½
Hydrated .....lb.		.12 – .14

Current Prices—(Continued)

	Carlots.	Less Carlots.
Potassium nitrate .....lb.		.09¾– .10
Powdered blue.....lb.		.30
Salt cake, for glassmakers..ton	28.00 –30.00	
Selenium .....lb.		2.25
Soda ash, 58 per cent dense, bulk .....100 lb.	1.72½	1.85
Sodium nitrate .....lb.	.06	.07
Sodium selenite.....lb.		2.25
Sulphur (flowers) .....lb.	.03¼	.03½
Uranium oxide .....lb.		2.25
Zinc oxide (ZnO).....lb.	.09½	.10

Stock Quotations

(Reported by Moore, Leonard & Lynch, Frick Building, Pittsburgh, Pa.)

Pittsburgh Stock Exchange—March 7.

	Bid	Offer	Last
Am. Window Glass Mach. com.....	104	105½	105½
Am. Window Glass Mach. pfd.....	82	84	84
Am. Window Glass pfd.....	98	100	100
Pittsburgh Plate Glass.....	113	115	115
U. S. Glass	..	52	58

Market dull with slight recessions.

Wheeling Stock Exchange—March 7.

Fostoria Glass Company.....	112	118	112
Hazel Atlas Glass Company.....	148	152	152
Imperial Glass Company	118	120	120
Central Glass Company.....	150	..	150

Market very strong and active.

Toledo Stock Exchange—March 7.

Libbey Owens Sheet Glass com.....	115	120	120
Libbey Owens Sheet Glass pfd.....	96	98½	97
Owens Bottle Machine common.....	49	50	49
Owens Bottle Machine pfd.....	..	100	..